Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING
FIVE DOLLARS A YEAR

OCTOBER 1954

Select Stainless For Fabricability

Automotive Superchargers

Open-Blade Snap Switches

Thin-Wall Cylinders

Radiant Heat Finishes

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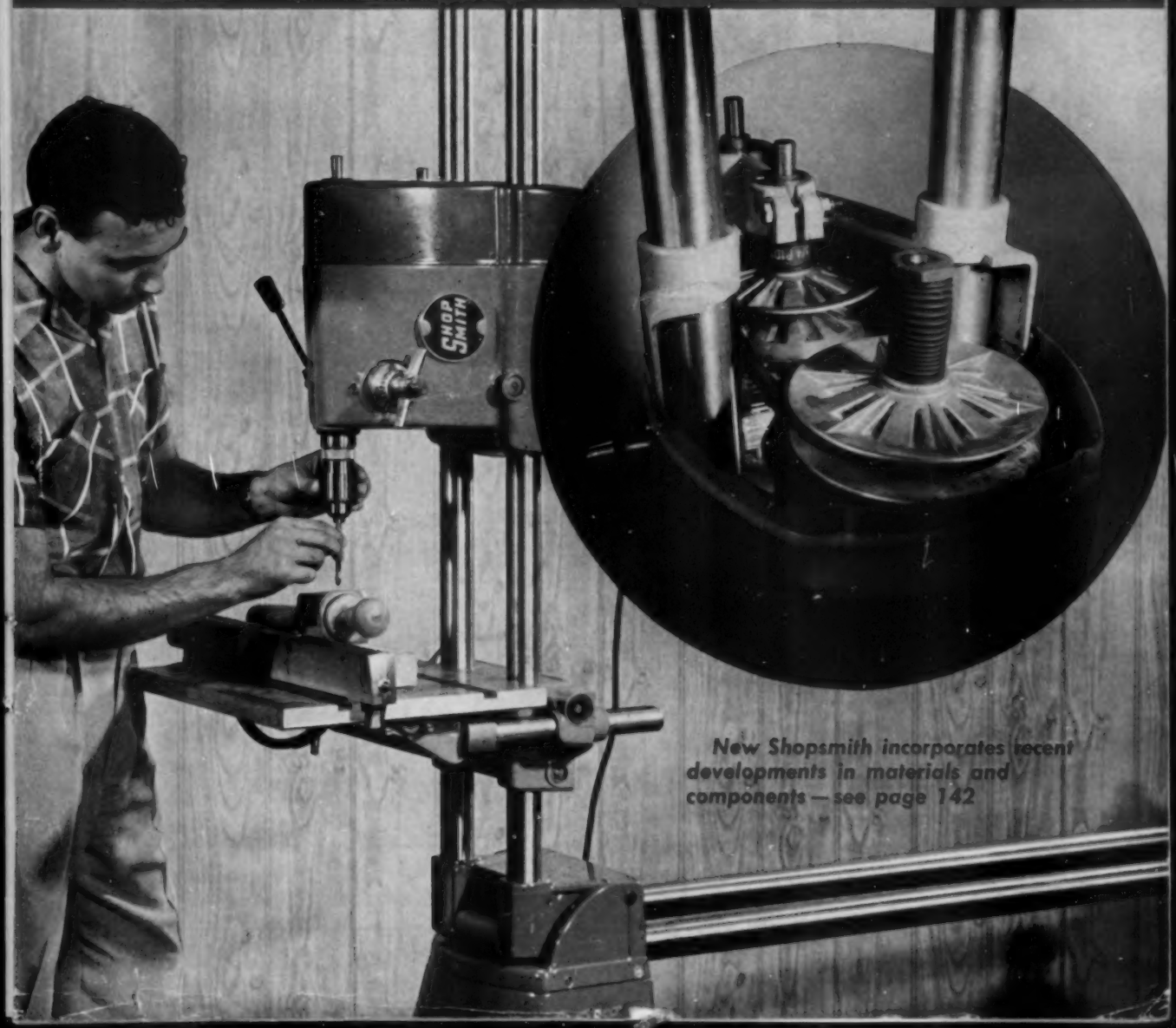

New Shopsmith incorporates recent developments in materials and components — see page 142

FUEL PROOF

FORCE-FEEDS 10,000 HUNGRY HORSES

Making jet engines thrive on strange diets in many climates requires the most exacting specifications in a pliable part. That's why C/R Sirvene (synthetic rubber) was the logical choice for this fuel control regulator diaphragm. It handles fuels ranging from kerosene up through the aromatics. It feeds them fast, under high pressure, and does the job dependably at −65° and 200°F. plus. Like all Sirvene parts, this diaphragm is completely custom developed—through design, compounding of oil-resistant elastomers, molding, and laboratory-like control of production. Also, it is the result of cooperation . . . the complete cooperation that C/R engineers will be glad to provide for your similar problems.

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ROSS Control VALVES

Ross OPERATING VALVE CONTROL COMPANY

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See How FORGINGS CAN SAVE MONEY

(Below) This forged brass part was originally made from a casting and a tube, silver soldered, as indicated in the drawing. Forgings can save a lot of money!

Photos of forgings shown are approximately 3 times larger than actual size.

(Above) Brass part as now forged in one piece. Drawing shows how it was originally made in three pieces, two made of tube and the other from sheet, silver soldered.

The two brass parts shown here were originally built up out of separate pieces, silver soldered together. That was the difficult and expensive way. Then the manufacturer and Revere worked together to see if forgings could not be used. Designs and dies were worked out, and for a number of years Revere has kept a steady flow of these parts going to the customer. He reports that the forgings not only save money, but are superior: stronger, more dense, with a better finish, and machining is faster and easier.

If you have sub-assemblies made of several parts, look into forgings. They may offer important economies. Revere makes forgings in copper and its alloys, and aluminum alloys. See the nearest Revere Sales Office.

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New Water-sealed Jack

for Communication, Audio and Other Electronic Applications

This new Mallory Jack effectively seals out water and moisture . . . lets your customers keep the dependable performance they bought, even when your equipment is operated out in the open . . . in all kinds of weather.

You can see how it is done in the cross section. A Neoprene "O" ring seal is tightly compressed around the shoulder of the bushing and against the inside portion of the panel board. Water can't possibly reach the jack opening and penetrate through to the inside of the chassis.

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WS-A2B—a three-circuit jack with terminals for two circuits and ground.

Both types conform to Specification JAN-J-641, Amendment No. 1.

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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear. These items represent current research and design developments soon to influence product engineering.

METALLIC MATERIALS

..Molybdenum research is being expanded to study molybdenum chemicals and molybdenum-base alloys for high temperature use. Climax Molybdenum Co., 500 Fifth Ave., New York, New York, reports that the chemical program will be devoted mainly to research in molysulfide, one of the newer lubricants; molybdenum catalysts, for upgrading low octane gasolines; and in the synthesis of new chemicals.

FUTURE ALLOYS . . . .

. . . .of nickel or cobalt-chromium hardened with molybdenum, tungsten, carbon, titanium and aluminum, are expected to consistently withstand temperatures above 1,600 F—present limit is about 1,500 F. Carboloy Division, General Electric Co., P. O. Box 237, Roosevelt Park Annex, Detroit 32, Michigan, believes that the method of manufacture—by vacuum—will be one reason for the higher temperature limit.

COMPACTING POWDER . . . .

. . . .for the manufacture of mechanical parts (not bearings) has been developed for where exceptionally high tensile and tranverse strengths and wear resistance are needed without unusual ductility. According to the National Radiator Co., Central Ave., Johnstown, Pa., parts made from this material—to which various percentages of copper have been added—show narrowly-restrained growth upon sintering. Parts having three per cent copper are reported to be equivalent in strength to conventional iron powder parts with as much as ten per cent copper.

TUNGSTEN CARBIDE . . . .

. . . .has still another use—as a work roll material for several types of rolling mills. Metal Carbides Corp., 103 E. Indianola Ave., Youngstown, 7, Ohio, reports that the rolls are giving superior service life in the rolling of all types of steel. Also: carbide rolls give an exceptionally smooth and flat surface to the strip rolled. This—it is reported—reduces the plating material required to plate the steel.

A WELDABLE . . . .

. . . .high-strength titanium alloy sheet—containing 5 per cent aluminum and 2.5 per cent tin—has been developed by Rem-Cru, Midland, Pa. Sheet is said to be readily weldable with the same techniques used for commercially pure titanium. Alloy also has excellent ductility in fusion-welded joints. Minimum tensile strength at room temperature is reported to be 115,000 pounds per square inch.

NICKEL BASE ALLOY . . . .

. . . .permits turbojet engines to deliver greater thrust than previously possible. Reason: greater heat-resisting qualities at operating temperatures of 1,500-1,600 F than other wrought alloys. Developed by Pratt and Whitney Aircraft Co., Main St., East Hartford, Conn., the material uses chromium, cobalt, molybdenum, and small amounts of titanium and aluminum. It is designed to resist fatigue, stretch and rupture.

CREEP STRENGTH. . . .

. . . .of a 90-10 cupro-nickel alloy is more than doubled when the iron content is increased from 0.68 to 1.08 percent according to tests made at the Chase Brass and Copper Co., 1949 Rodney St., Waterbury, Conn. Previous studies indicated that alloys of this type—with the higher iron content—are more resistant to corrosion.

NONMETALLIC MATERIALS

. . . .Development work with continuous foam vinyl production to form continuous sheet or molded items is being undertaken by the B. F. Goodrich Chemical Corp., 324 Rose Bldg., Cleveland, Ohio. The procedure—patented by the Elastomer Chemical Corp., 212 Wright St., Newark 5, N. J.—is to dissolve an inert gas under high pressure in a vinyl plastisol. The foamed plastisol is released through a spray nozzle into a mold or on a casting surface, where the material is fused to form the finished product.

SANDWICH CONSTRUCTION . . . .

. . . .consisting of honeycombed material between sheets of metal or plastic are being used for structural parts on aircraft. Narmco Mfg. Co., 930 West Grape Bldg., San Diego, Calif., are constructing wing tips, leading edges and other structural parts from this material. Previously, only non-structural parts were made by sandwich construction.

(continued on page 7)

hold on to sales appeal

WITH HANDLES BY KURZ-KASCH

The handle's your customer's first contact with your product. Many times the sale can be made—or lost—at this crucial moment. Your designers know how to design sales appeal into a handle. Help them hold on to their design by bringing it to Kurz-Kasch.

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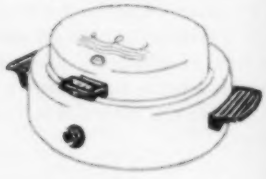

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EXPORT OFFICE: 89 Broad St., New York City, *Bowling Green 9-7751*.

Highlights

SMALL QUANTITIES . . . .

. . . .of almost chemically pure silicon dioxide with a particle size of only 10 to 20 millimicrons is being manufactured by the Dow Corning Corp., Midland, Mich. The silica—produced by burning silicon tetrachloride in the presence of combustible gases—has a higher degree of purity and particle separation than silicas formed by precipitation processes. Suggested uses are: as a reinforcing filler for synthetic rubbers and plastics; a flatting agent and extender for protective coatings; a thickener for lubricating greases; and an additive in textile finishing.

NEW PETROCHEMICAL. . . .

. . . .the outcome of a 7 year research program is suggested for use in high frequency electronic equipment. Standard Oil Development Co., 15 W. 51 St., New York, N. Y., states that the material is heavy-bodied, sticky and almost colorless liquid, based on butadiene. It has been tested to produce glass-like plastics, which may be machined like metal and with excellent electrical properties. Surface coating applications are being developed by the company.

SYNTHETIC RUBBER. . . .

. . . .that has resistance to corrosive chemicals—such as fuming nitric and sulfuric acids, hydrocarbon fuels and lubricants—is a joint development of the Quartermaster Corps and the M. W. Kellogg Co., 225 Broadway, New York 7, N. Y. The elastomer is non-flammable, abrasion and heat resistant, serviceable from —15 to +400 F and has good insulation characteristics. Applications are expected in fuel hose, diaphragms, gaskets, seals and O-rings.

COMPONENTS

. . . .Temperature measurements can be accurately taken of molten metal directly as it is tapped from the furnace. Eliminated are complicated correction charts. Leeds and Northrup Co., Rockland & Stenton Aves., Philadelphia 44, Pa., states that the molten metal runs through a trough to a special container where it swirls around, forming a vortex. A pyrometer can be sighted into the vortex for a true temperature reading. Sunlight, oxide films on the metal, or slag mixed into it do not affect the temperature reading.

CUTTER BLADES . . . .

. . . .for millers have been patented that permit their use even after repeated sharpenings. Viking Tool Co., 1000 Nichols Road, Shelton, Conn., reports that the blades clamp into notches in a cutter wheel and the backs of the blades are ribbed with grooves that fit similar grooves in the wheel. The bases of the blades are inclined sharply so that as the blade is shortened and made more narrow by grinding, one adjustment will compensate for the lost metal. When the blade becomes too small it may be used for the next smaller machine as a full-size cutter.

3 IN. DIA. . . . .

. . . .valve body-made of styrene copolymer—has been designed by the U. S. Rubber Co., mechanical goods division, 1232 Avenue of the Americas, N. Y., 20, N. Y. Size of valve more than doubles the capacity heretofore possible. Chemical solutions and acids that quickly destroy ordinary pipes can now be handled, it is claimed, in completely corrosion-resistant and non-contaminating piping systems of greater capacity than ever before.

LIGHTWEIGHT FLEXIBLE TUBING . . . .

. . . .that can be used—without fear of collapsing—where bends up to 180 deg must be made and is capable of withstanding temperatures ranging from —65 F to 250 F, is a development of the Chemical Div., General Electric Co., 1 Plastic Ave., Pittsfield, Mass. The tubing is to be used to duct pulsating air pressure to the leading edge of aircraft wings for de-icing purposes.

PROCESSES

. . . .Large size powder metal parts can be made by the application of the sinter welding technique. The Atomic Energy Div., Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y., reports that two parts can be joined by inserting a metal hydride between the two compacts and hot pressing. Also: metal powders can be compacted by rolling, thus forming a shell or long strip which may be several hundred feet in length without a joining seam.

ALUMINUM WELDING ELECTRODE . . . .

. . . .has been developed that provides maximum weld quality in the inert-gas, shielded arc welding of aluminum. Alcoa, 1501 Alcoa Building, Pittsburgh 19, Pa., states that the electrode is designed for use in welding guns presently used for the shielded arc processes.

FLAME PLATING . . . .

. . . .that deposits a thin coating of tungsten carbide on the surfaces of parts and tools where extra resistance to wear is required is a development of the Linde Air Products Co., a division of Union Carbide and Carbon Corp., 30 E. 42nd St., New York, N. Y. Parts made of many common metals, it is claimed, can be

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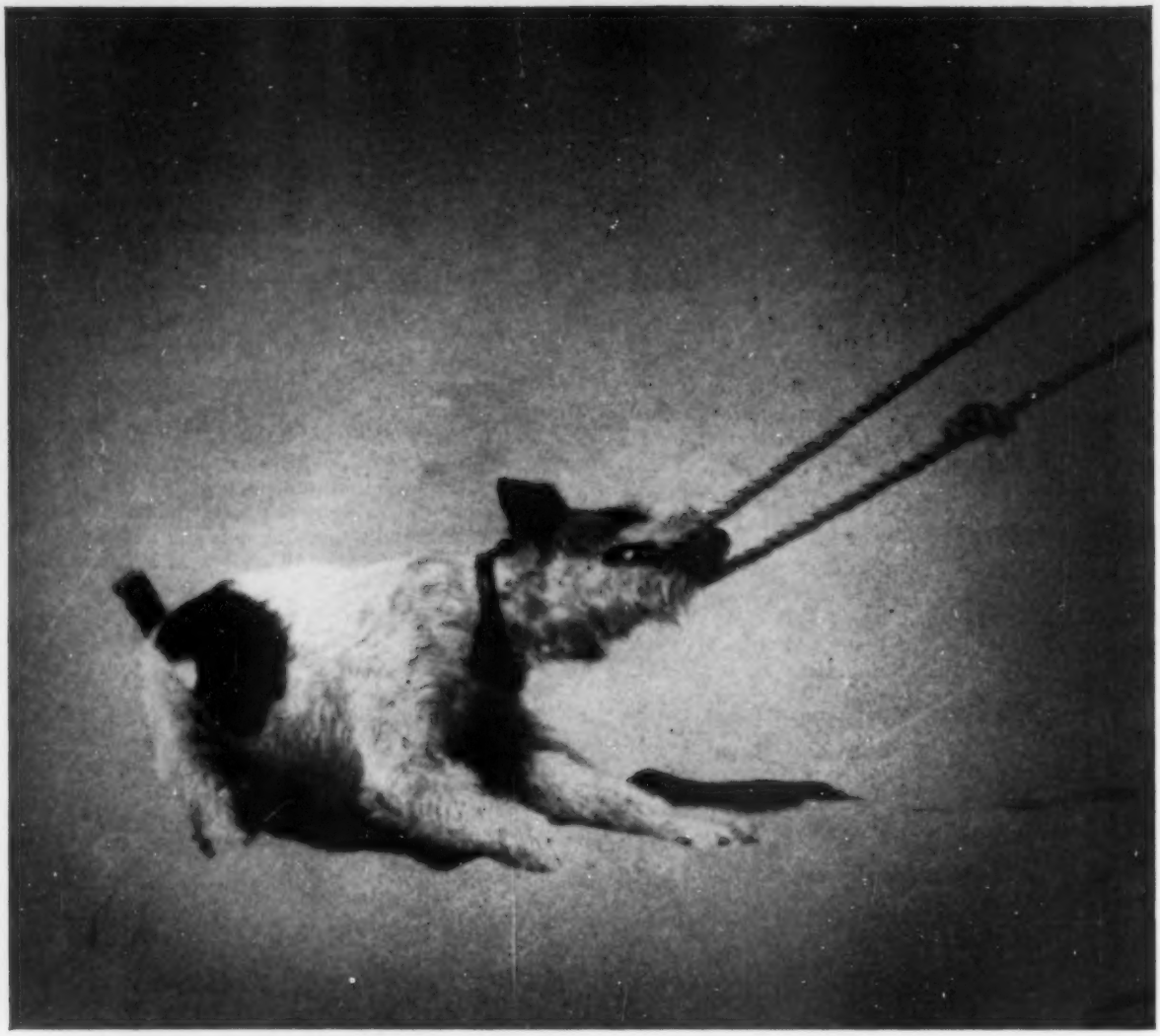

BONDERITE holds paint to metal!

There's a constant tug-of-war between corrosive action and the paint finish on your metal products. The paint tries to stick to the metal; the natural forces of corrosion try to lift it off.

Bonderite is the "anchor man", throwing its strength on the side of lasting, durable paint finishes.

This excellent product, simple and economical in operation and uniformly effective in results, creates a nonmetallic coating integral with the metal surfaces. The coating anchors organic finishes, is a stout corrosion resistant, and prevents the spread of finish failure should the paint film be broken by scratch or dent.

Bonderite adds quality to painted metal products by lengthening the durability and appearance life of paint finishes. Bonderite adds sales appeal because your customers know about it and the benefits it brings.

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corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

Highlights

flame plated to produce unusual metallurgical properties, such as wear-resistance with light weight or toughness. Plating temperature is about 400 F and does not alter the properties of the base metal.

TURBINE BLADES . . . .

. . . .forged of a titanium alloy are to be used for the jet engine of a new fighter plane. Tests, by A. V. Roe Canada Ltd., Box 430, Terminal "A", Toronto, Ontario, at high temperature and under high spinning stresses left the blades unchanged in shape. Also: they did not break down or corrode at increasing speeds. The forgings pressed from dies—by Canadian Steel Improvements Ltd., Toronto, Canada—were of such accuracy that only the leading edges of the blade and the blade root needed machining.

TESTING

. . . .Tests on type 75 A titanium—0.1 per cent Fe, 0.02 per cent N, 0.04 per cent C, 0.08 per cent W—indicate that optimum softness without danger from embrittlement is obtained by stress relief annealing at 1,100 F for 1 hr. Goodyear Aircraft Corporation, 1220 Massillon Rd., Akron, Ohio, says that stress relief annealing of blanked, formed and drawn titanium alloy parts is desirable to prevent failure in fabrication or in service operations.

HEAT SENSING CELL . . . .

. . . .small slips of glass coated with lead sulfide—is reported to give 10,000 times as much sensitivity to certain infrared rays as previous laboratory instruments. Eastman Kodak Co., 343 State St., Rochester 4, N. Y. believes that the sensitivity of the cell, coupled with their simplicity and adaptability to manufacture, opens the possibility of developing new devices based on the ability to detect warm objects without physical contact and over long distances. Top sensitivity is in the invisible heat rays of near infrared. The cell is also sensitive to all colors of visible light and on into the ultraviolet range. Water and gasoline, for example, can be detected by variation in color to the cell.

TEST DIES . . . .

. . . .of ductile iron have many advantage over the conventional steel types. The fact that they can be cast close to final contour, hand finished, then hardened and tempered in about 1/3 the time than needed for steel units is a major advantage says North American Aviation Inc., International Airport, Los Angeles, Calif. For example: a joggle die in ductile iron was finished in about 50 hr; in tool steel in about 160 hr. Also: the material can be cast and machined like cast iron but possesses the strength of steel. This permits long die life and low production costs.

CAPACITANCE RECORDER . . . .

. . . .permits the continuous checking of a fluid passing through a pipe line. Developed by the Gulf Oil Corp's Research Laboratories, Gulf Bldg., Pittsburgh, Pa., the device functions by revealing variations in electrical properties of fluids as they pass between fixed electrodes within the pipe. Recorder can even differentiate between grades of gasoline. Changes are recorded on clock-driven chart and appear as variations on the chart.

This Month's Cover

Shown positioned as a vertical drill press, the new Shopsmith was designed by Magna Engineering Corp., Menlo Park, Calif., as a versatile, multi-purpose power tool without duplication of any parts. The insert view underscores one of the machine's outstanding design features—that of a variable speed power transmission. Details of this and other design features, such as material selection, mechanical elements and styling, can be found starting on page 142 in this issue.

In Coming Issues

SINTERED NYLON—offers a new material for bearings; properties and applications given.

DAMPING CAPACITY—practical method for analyzing and evaluating, and data on a variety of materials.

LINKAGE DESIGN—four methods compared for determining a coupler point path.

AUTOMATIC SPINNING—materials suitable for the process; comparison with other methods of forming.

DUTY CYCLE—effect of requirements for frequent starting, plug-stopping and fast reversal in selecting motors.

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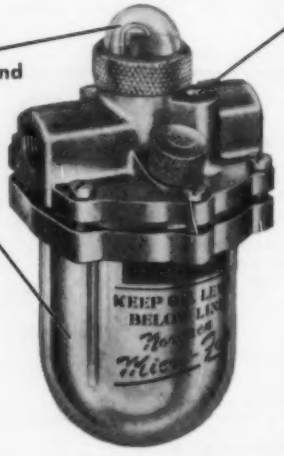

oil feed controlled by auxiliary air circuit ...gives an accurate and uniform rate of oil feed.

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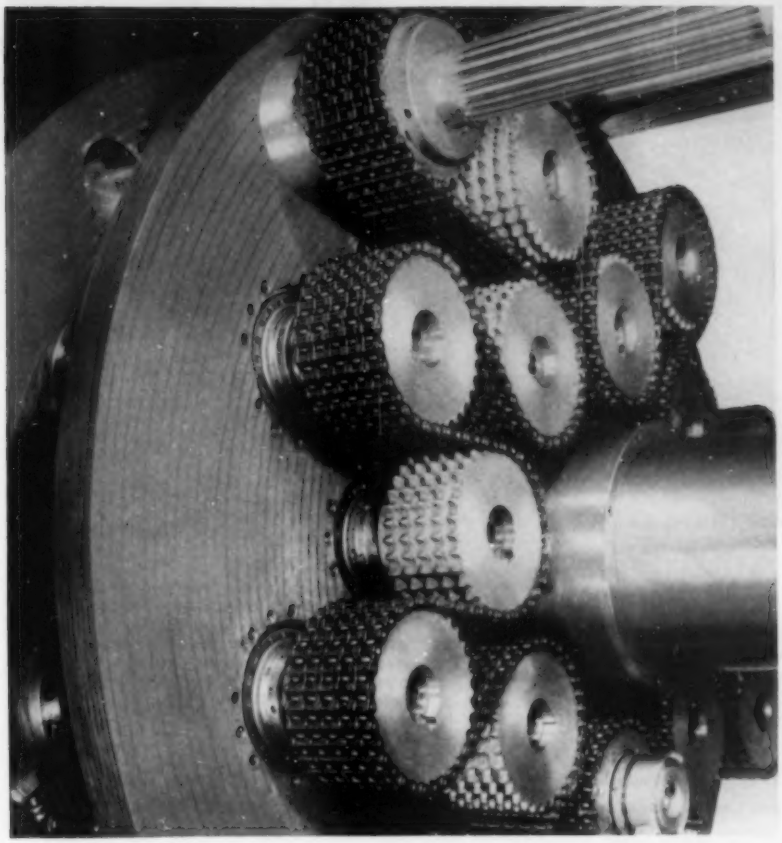
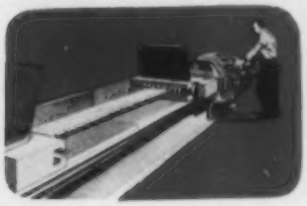


LOCK-TYPE BUSHINGS (applied on a range of sizes) end a common cause of stiff chain.



PRE-STRESSING of multiple width chain provides uniform load distribution.

SHOT-PEENED ROLLERS have greater fatigue life, added ability to withstand impact.

* And you pay no premium for these LINK-BELT extras

THERE'S more to roller chain than just the parts you see. *Much more!* It's the hidden extras—standard on Link-Belt Precision Steel Roller Chain—that add up to better performance, longer life and greater dependability for your machines.

Check the three extras shown above. Then choose from the broad range of Link-Belt roller chains and sprockets: Single or multiple widths, ¼″ through 3″ pitch. Double pitch, 1″ through 3″.

There's full ordering and application information in 148-page Data Book 2457. Ask your Link-Belt office for a copy today. Link-Belt's complete line of drive and conveying chains includes silent chain drives . . . all sizes and types of cast, combination, forged and fabricated steel chain.

LINK-BELT

CHAINS and SPROCKETS

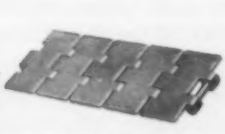
LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.644

No one chain serves every purpose . . . get the RIGHT one from Link-Belt's complete line

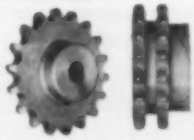
Silent Chain for high speed drives from fractional to thousands of hp. Available in wide range of pitches and widths in middle guide, duplex, non-flange and side flange types.

LXS Steel Chains, with offset or straight sidebars, are made to close tolerances. Ideal for rugged drives, conveyors.

Detachable Link-Belt chains, available in steel, malleable or Promal, for light-strength drives and conveyors.

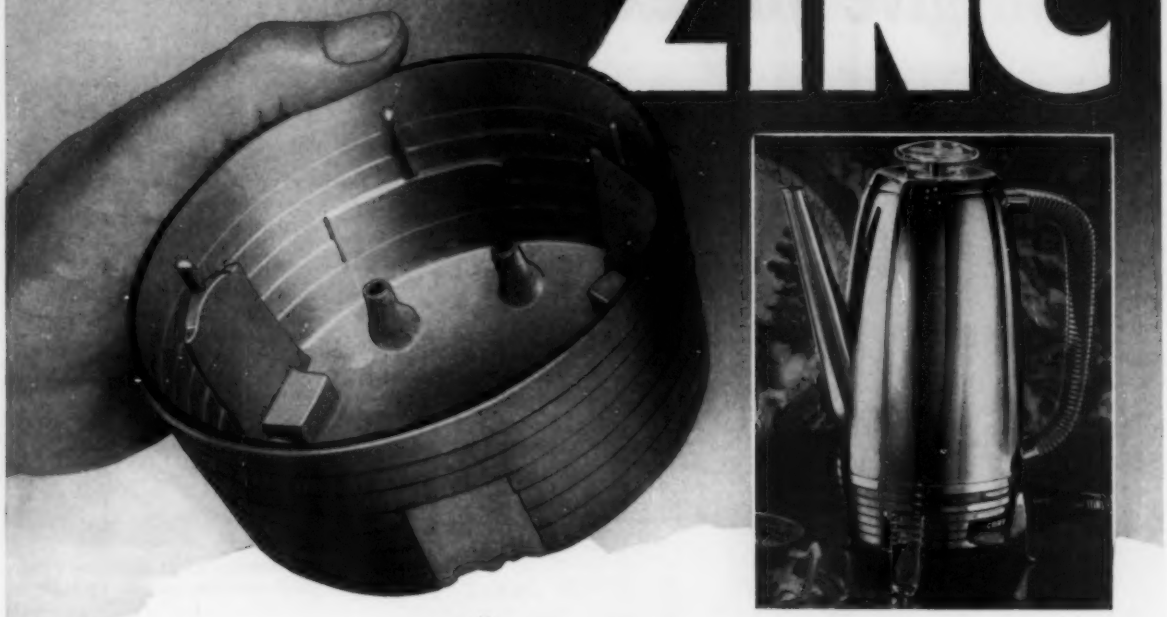


S-815 Flat-Top Chain—easy to detach and keep clean — one of complete line for carrying bottles, cans, cartons, cases, etc.



Complete line of single and multiple width cut tooth sprockets as well as a wide range of cast tooth sprockets.

DIE CAST OF ZINC



for CORY

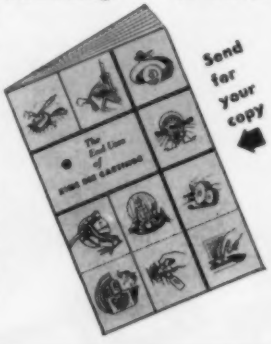
The "innards" of the "Crown Jewel" incorporate mechanical innovations which are claimed to insure retention of the flavor-bearing coffee oils. Its body, spout and cover are gleaming stainless steel, its raffia style handle is heat-proof plastic, and its base, legs and handle holders are ZINC Die Cast.

Here's Why . . . .

In designing the beautiful new "Crown Jewel" automatic electric coffee percolator, the engineers of the Cory Corporation spared nothing in their effort to make this product the finest in its field. And the dual objective of maximum beauty and utility was achieved, in large measure, through the use of six ZINC Die Cast components. Of these, the above base casting is the most outstanding.

This ZINC Die Casting is shown as it is received by Cory from the die caster. The stepped exterior design is clean-cut—with recesses for the legs—and a minimum of preparation is required to coat the as-cast surfaces with a handsome and durable 24-karat gold plate. The interior of this sturdy ZINC Die Casting has a cored center hole and cast bosses and splines which facilitate assembly of the thermostat controls and attachment of the base assembly to the body unit. Furthermore, the Cory name and address and other nameplate data for the percolator are engraved on the bottom of the base in the die casting operation.

The "Crown Jewel" is just one of a great many new products made more salable through the use of ZINC Die Castings. For additional examples ask us—or any die casting company—for a copy of "The End Uses of Zinc Die Castings."



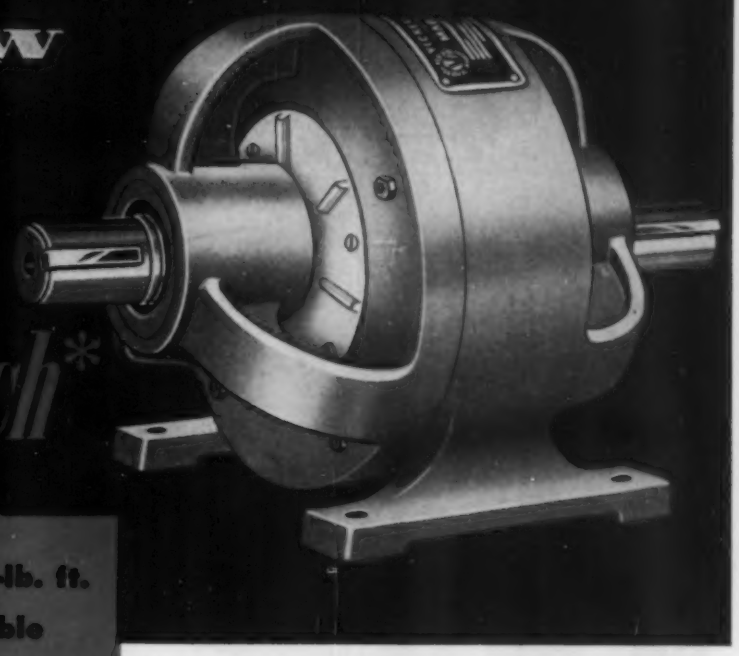
The New Jersey Zinc Company
160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

...new

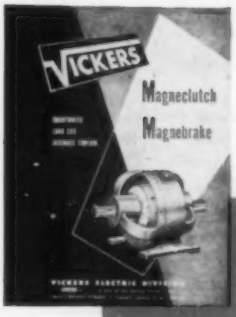
Vickers Magneclutch*



10- 45- 100- 200-lb. ft. models available for immediate delivery.

for dependable, easily regulated torque control and power transmission

Vickers Magneclutch* offers you these outstanding... advantages



VICKERS MAGNECLUTCH may also be used for braking and tension control. Get the complete facts. Write today for new bulletin and application data forms.

SMOOTH OPERATION
No grab or chatter

LONG LIFE
No wear on torque transmitting surfaces

TORQUE AT ZERO SLIP
Torque transmitted 100% without mechanical lockup

TORQUE LIMITING
Torque easily adjustable from minimum to full rated torque

EXTREMELY FAST RESPONSE

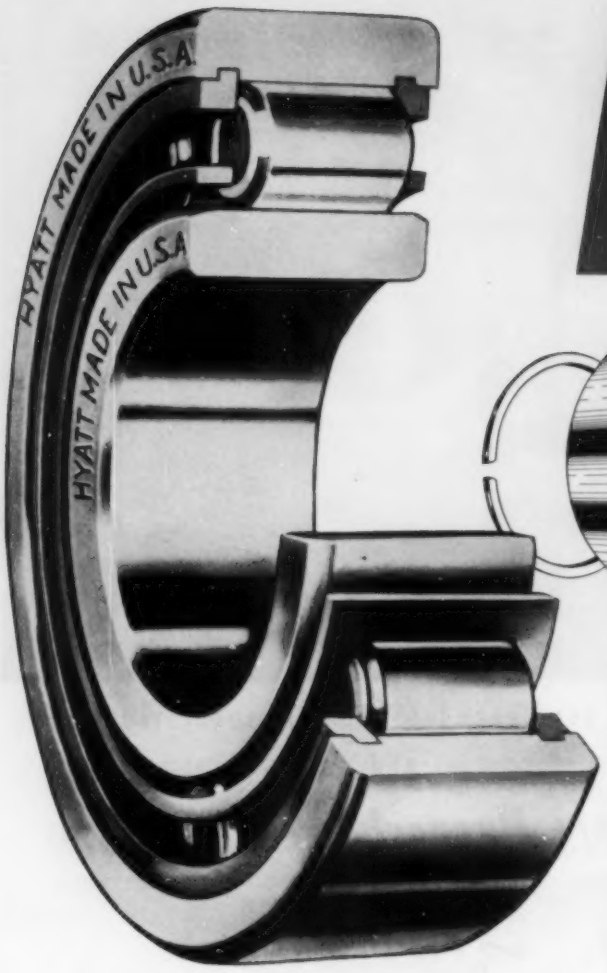
SMALL CONTROL POWER

EASILY ADAPTED TO REMOTE CONTROL

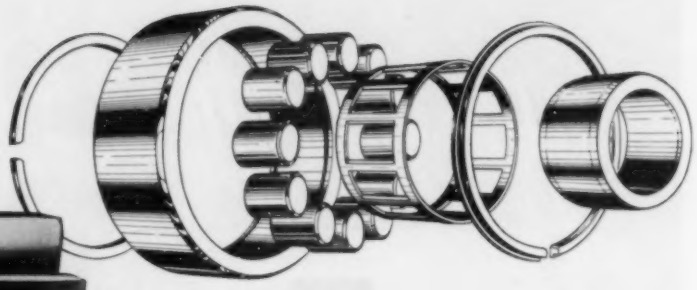
*Trade Mark

VICKERS ELECTRIC DIVISION

VICKERS Inc.
A UNIT OF THE SPERRY CORPORATION
1819 LOCUST STREET · SAINT LOUIS 3, MISSOURI



A-TS



one of many Hyatt bearings offering capacity–separability–long life

The Hyatt A-TS Bearing is one of five basic Hy-Load types featuring a separable inner race.

Like all Hy-Loads, the A-TS is built with cylindrical rollers, so that it offers highest capacity for radial loads, plus the long, troublefree service assured by Hyatt's precision manufacture. But beyond that, this particular Hy-Load type offers the design advantages of interchangeable separable components.

With inner races removed, bearings of this type may be applied with rollers operating directly upon the surface of a suitably hardened shaft. This permits the use of larger-diameter shafts or smaller-size bearings, resulting in greater shaft rigidity or a saving in the cost of the bearing.

If you aren't already profiting through the use of Hyatt Hy-Load Bearings, contact a Hyatt sales-engineer or write today for our Catalog No. 150.

HYATT ROLLER BEARINGS

STRAIGHT ▯ BARREL ▯ TAPER ▯

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

THIS SLUDGE DIDN'T RUIN AN AIR CYLINDER

proved protection of air equipment with *Norgren* filters

Here's a typical example of why it is essential to filter the air that powers your tools, cylinders, and other pneumatic equipment—if you want best equipment performance and low maintenance costs.

Norgren Filters give you this vital protection. Performance data prove their high efficiency in water removal . . . and, at 80 psi line pressure and flow of 100 cfm, pressure drop across filter is only ½ psi.

C. A. *Norgren*® CO.

3428 SO. ELATI ST., ENGLEWOOD, COLO.

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

• VALVES • FILTERS • REGULATORS
• LUBRICATORS • HOSE ASSEMBLIES

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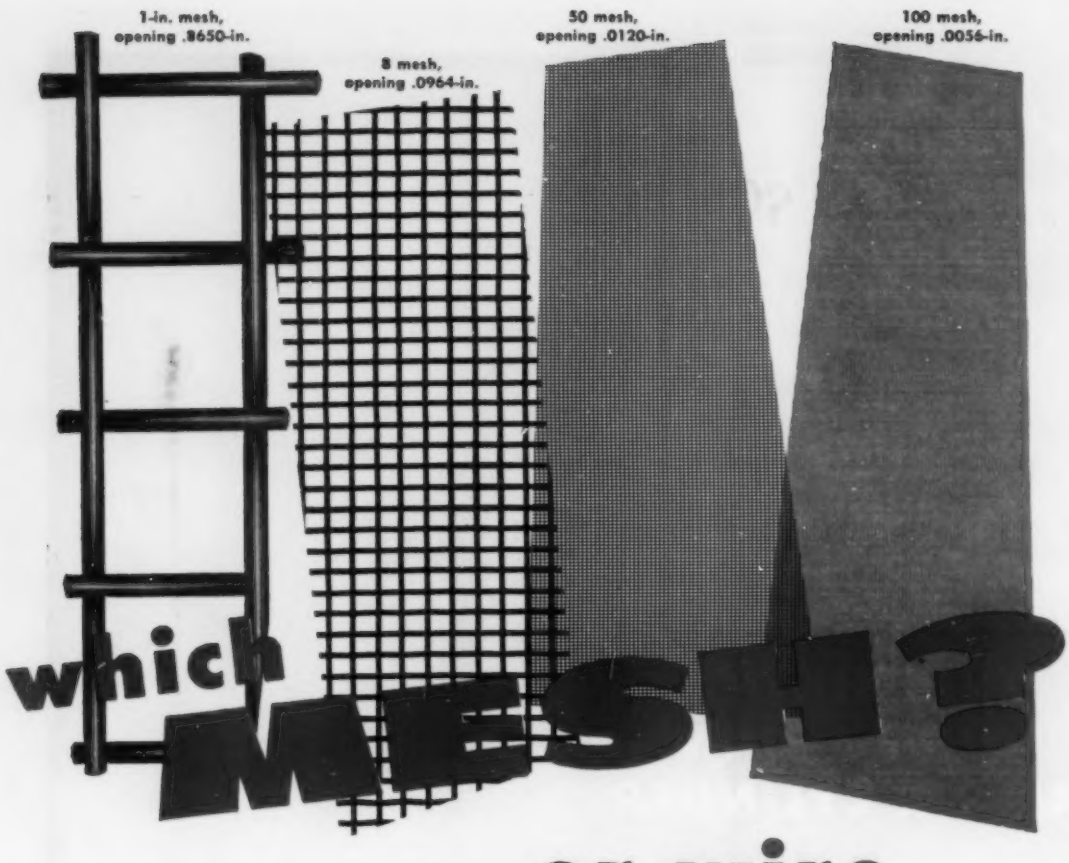


...or wire
...or weave
...or metal

Mesh is the number of openings per lineal inch, measured from the center of any wire. It is only *one* of many factors to be determined in finding the right industrial wire cloth to fit precisely the job it must do in your product.

Then there's the question of the gauge, metal or alloy, and coating of the wire. The weave, weight, strength, flexibility, resistance to atmospheric and chemical corrosion of the cloth itself. And more.

If it is Reynolds industrial wire cloth it will be *right*—precision processed to your specifications.

Or, if you have wire cloth problems, Reynolds Engineers are ready to help you find the right answer.

Details in Sweet's product design file.

Reynolds WIRE CLOTH for Industry

NS NATIONAL-STANDARD Company NILES MICHIGAN

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., Box 200, **DIXON, ILL.**

Divisions of National-Standard Co.

ATHENIA STEEL...*Clifton, N. J.*.....Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.*.....Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY...*Jersey City, N. J.*.....Metal Decorating Equipment
WORCESTER WIRE WORKS...*Worcester, Mass.*....Round and Shaped Steel Wire, Small Sizes

Added Evidence that

Everyone Can Count on VEEDER-ROOT

REPORTER AT LARGE . . . that's what you might call this new Veeder-Root Reset Magnetic Counter . . . adaptable to remote counting from machines or processes to central boards or instrument-clusters, wherever you want to put them. NOW . . . what can your imagination do with these few facts? For the *full facts*, write:

VEEDER-ROOT INCORPORATED

"The Name That Counts"

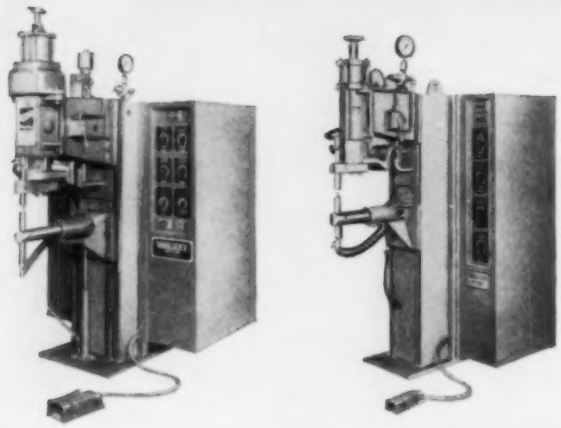
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

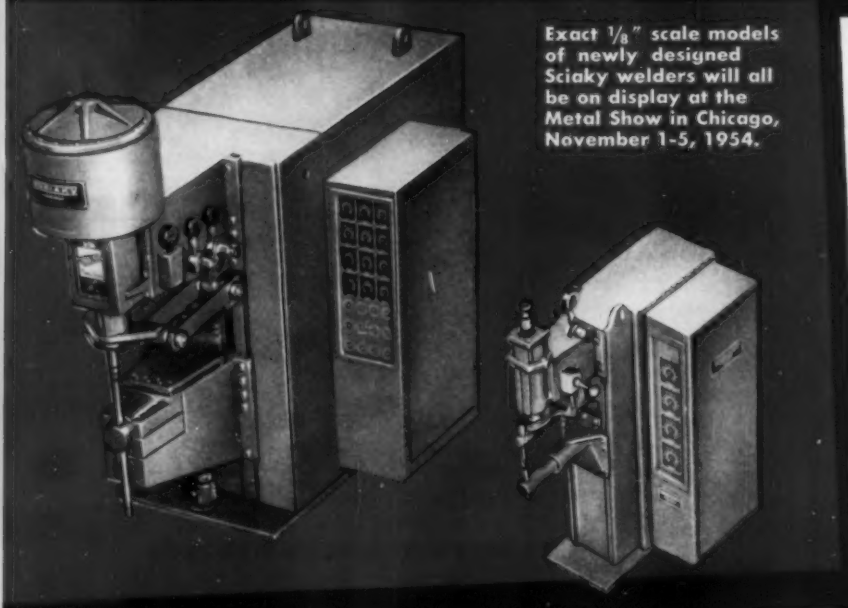
"Counts Everything on Earth"

See the new concept in

RESISTANCE WELDING



SPECIFICALLY DESIGNED FOR INDUSTRIAL APPLICATIONS



Exact 1/8" scale models of newly designed Sciaky welders will all be on display at the Metal Show in Chicago, November 1-5, 1954.

••• You may find a solution to a fastening problem similar to yours. Be sure you don't miss Sciaky Booth 435 and the typical illustrated applications to resistance welding. Complete details of the applications displayed are contained in free copies of the Sciaky bulletin, "Resistance Welding at Work." If you are not already on the mailing list, ask to be included — it's free, of course!

••• Be sure and examine the much-talked-about, exact 1/8" scale models of the newly designed Sciaky welders at Booth 435. These models have met the most determined challenges of the entire Sciaky Engineering Staff. Besides being interesting to see, the models show many interesting features of the completely new Sciaky design.

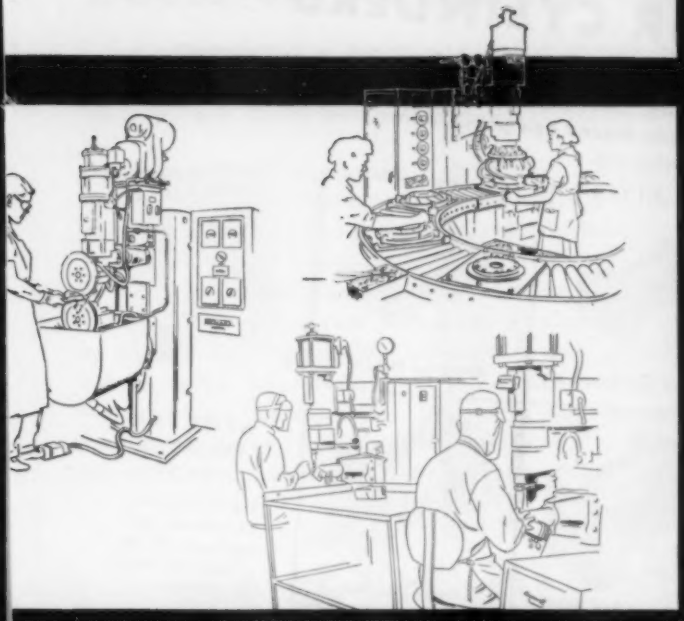
BOOTH

435

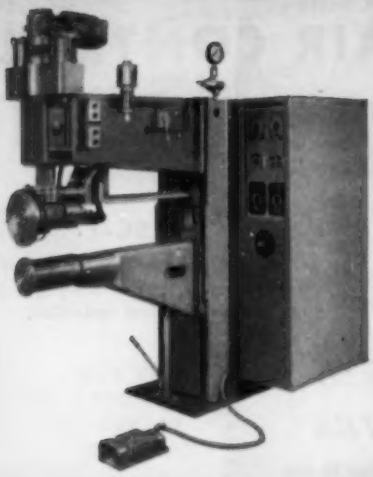
NATIONAL METAL EXPOSITION
November 1-5, 1954
International Amphitheatre
Chicago, Illinois

MACHINES

BOOTH
435



Sciaky's display for Booth 435 will contain new Sciaky welders, illustrated application stories, plenty of new literature, and those talked-about scale models — don't miss it!



STOP at Booth 435 at the Metal Show and examine first hand the new concept in resistance welding machines designed by Sciaky.

Experienced Sciaky Application Engineers will answer any questions you may have. Take this excellent opportunity to discuss any fastening applications you may be contemplating.

Visit the Sciaky Plant while in Chicago. Get information and date of the plant "Open House" at Sciaky Booth 435. This is your opportunity to see the unique facilities that produce the entire welder — frame, transformer, pneumatic system, electronic controls, and all!

Remember, stop at the Sciaky Booth 435 at the National Metal Exposition, November 1-5.

SCIAKY

Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY BROS., INC., 4913 W. 67th St., Chicago 38, Ill., Portsmouth 7-5600

HANNIFIN SQUARE

SERIES "A" AIR CYLINDERS

Made in 11 bore sizes from 1½" to 14"...13 standard mountings...many combinations. Extremely close tolerances insure accurate, easy mounting. Steel heads. Cylinders of hard-drawn, high strength brass honed to a satin finish. Piston rods ground and polished then hard chrome plated for extreme smoothness as well as corrosion resistance.

TYPICAL MOUNTING STYLES

WRITE FOR BULLETIN 213

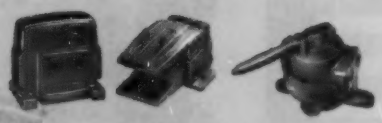
Just off the press. The easiest catalog to use in the cylinder business. Write today.

HANNIFIN AIR CONTROLS

Hannifin has the most complete line of air control valves. Exclusive designs, many types, for hand, foot, cam or solenoid control of air cylinders, presses, and other air-operated equipment. Ask for recommendations.

P-M PILOT-MASTER VALVES

The P-M line provides faster, easier operation for the simplest to the most complicated air-operated circuit. 2-Way, 3-Way and 4-Way Master Valves and Solenoid Pilot-Master Valves...also direct operated 3-Way and 4-Way valves with a wide choice of operating heads.



DISC-TYPE VALVES

Bronze discs lapped to perfect seal with seats. Packless design. For hand, foot or electrical operation.

WRITE FOR CONTROL VALVES CATALOG

The complete air controls catalog! Write for your copy today.

HANNIFIN

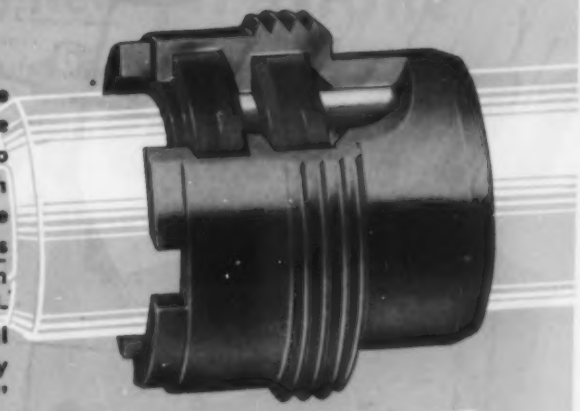
Hannifin Corporation, 525 South Wolf Road, Des Plaines, Illinois

Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Air Control Valves

TYPE CYLINDERS

BOTH WITH NEW, CARTRIDGE GLAND

...externally removable and replaceable without dismantling cylinder!



Here's the biggest improvement in cylinder design in the last 50 years. This exclusive Hannifin gland is a bronze cartridge, externally removable and replaceable as a unit to meet J.I.C. recommendations. A face type spanner wrench is the only tool you need. Now look at the packing! The "Wiperseal" serves a dual purpose as it wipes both ways to provide a dry rod on the out-stroke, a dirt-free rod on the in-stroke. The "Lipseal" is self-compensating, self-relieving and non-adjustable... provides an efficient seal throughout its long life. Ask for a demonstration... every Hannifin man carries a cutaway sample of this "jewel" of a gland with him at all times.

SERIES "H" HYDRAULIC CYLINDERS

Made in 9 bore sizes from 1½" to 8"... 13 standard mountings... many combination mountings. Extremely close tolerances for easy mounting. Heavy-duty tie rods. Steel heads. Steel cylinder bodies "Tru-Bored" and honed to a satin finish. Piston rods ground and polished then hard chrome plated for minimum friction and long packing life.

TYPICAL MOUNTING STYLES

WRITE FOR BULLETIN 113

Get your copy of this complete, easy-to-use catalog today. Everything you need to order from is here.

HANNIFIN

Hannifin Corporation, 525 South Wolf Road, Des Plaines, Illinois

Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Air Control Valves

Protective coatings get superior *plus* high

Outdoor durability unmatched by other vinyl resins!

Subjected to all elements for 1 solid year, a coating of EXON 471 reveals no measurable change.

Outstanding solution properties of

EXON 471

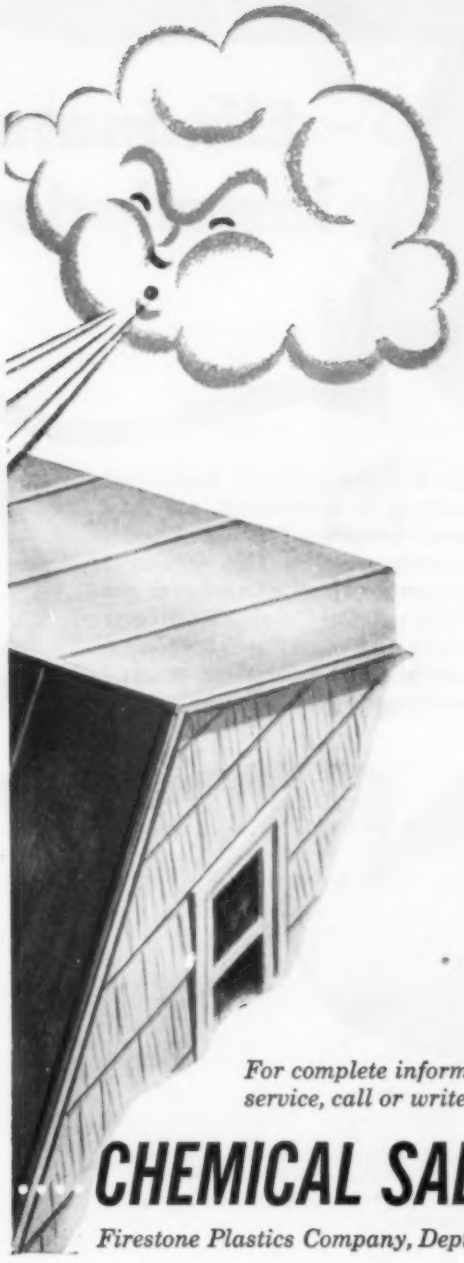
- High solubility in ketones
- Excellent chemical and grease resistance
- Good adhesion to vinyl, paper, cloth
- Moisture, vapor and water resistant
- Adheres well to "wash primer"
- Stable under heat and light
- Transparent, colorless, glossy

Firestone EXON

weathering and ageing qualities chemical resistance

with New Firestone

EXON 471



The newest resin in Firestone's expanding EXON line makes possible protective coatings with greater outdoor durability than previously offered by vinyls.

One-year outdoor exposure of EXON 471 as a clear glossy film has shown *negligible* changes. Other vinyl copolymer coatings similarly exposed deteriorated *in 3 months!*

Under sun lamp exposure for 360 hours as a 1 mil film, EXON 471 showed no *noticeable change!*

2-hour bakings in a 180° forced air-oven left *no sign of yellowing* on a film of EXON 471!

The foregoing results, plus the excellent solution properties of EXON 471, indicate its extreme efficiency in many types of solution coatings.

Since coatings of EXON 471 have no permanent adhesion to metal or glass, they also offer a "strippable" film, ideal as a protective factory-to-consumer casing.

Continuing Firestone research is providing industry with specific resins for specific needs. Whatever your problem, the answer may very likely be found in the ever-growing line of versatile EXON resins.

For complete information or technical service, call or write

CHEMICAL SALES DIVISION .....

Firestone Plastics Company, Dept. 6F, Pottstown, Pa., Division of the Firestone Tire & Rubber Co.

Now! The world's

ONAL RED

Eliminates installation

This bright colored Redicoat coating is available on any metal encased National seal. Together with the ground circumference standard on National Oil Seals, Redicoat offers the most perfect and economical metal-to-metal bore sealing available.

© 1954
National Motor
Bearing Co. Inc.

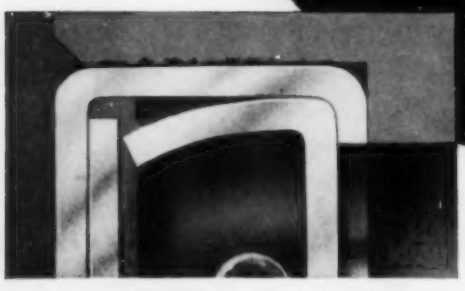


Figure 1. Cross section shows Redicoat seal installed in housing. Radial or circumferential scratches as deep as .003" are filled completely. Bore is sealed as Redicoat seal is installed; no drying or "setting" is required.

first pre-cemented oil seal!

ICOAT OIL SEALS

TRADE MARK

cementing—offers important economies on your production line

Now you can install press fit oil seals that insure a perfect, enduring seal between oil seal and bore as well as oil seal and shaft. You can eliminate danger of cement reaching and damaging sealing surfaces, and you can *completely eliminate cost of cementing on your production line.*

Amazing new National Redicoat is applied at NMB factories. Seals reach you pre-cemented smoothly and evenly all around the circumference of the outer case. The truly negligible additional cost of Redicoat is more than made up by your very real savings in assembly time and materials.

What is Redicoat?

National Redicoat is a material developed and applied by, and available only from, National Motor Bearing. It is dry to the touch, does not pick up dirt, and does not adhere to other seals or containers. It also prevents rust on the area covered.

Upon installation, a microscopic portion of the coating rolls up at the bore's edge (Figure 1) but the majority remains as a tough, stable cement filling all irregularities in the housing bore. Redicoat will last indefinitely even at temperatures −65° to +350° F. The fit is even more perfect than metal-to-metal with a ground outer case surface (as on all regular National seals). Seals may be removed easily, even after prolonged service at 300° F. No special preparations are needed for installation, and no tedious cleaning of the housing bore is required when Redicoat seals are removed and new seals installed.

NATIONAL OIL & GREASE SEALS O-RINGS SHIMS

NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, Calif.
Plants: Redwood City, Calif.; Van Wert, Ohio

NATIONAL MOTOR BEARING CO., INC., Dept. A
Broadway at National, Redwood City, California

Gentlemen: Please send information on Redicoat Oil Seals as applied to _____ (Type of Product)

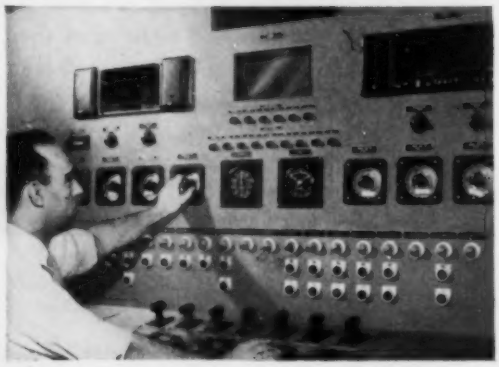
Name _____

Company _____

Street _____

City _____ Zone _____ State _____

World's largest dynamometer Friction Material Testing



This new dynamometer—rated at 51,000,000 ft. lbs. K.E.—is the largest ever designed exclusively for evaluating friction materials.

Built with the precision of a fine watch, it consists of a driven shaft carrying adjustable flywheel discs. In operation, the huge flywheels are rotated at controlled speeds by means of electric prime movers. On reaching predetermined speeds a test brake lining or clutch facing cuts in to absorb the energy in the flywheel assembly.

The flywheel weights can be varied to match the inertia load of the widest range of vehicles—from light automobiles to the heaviest bus, truck, plane, machine or earth moving unit.

An electronic instrument panel automatically cycles the starts and stops during operation and at the same time accurately computes and records torque, deceleration, brake input and temperatures.

Johns-Manville asbestos

designed for installed by Johns-Manville

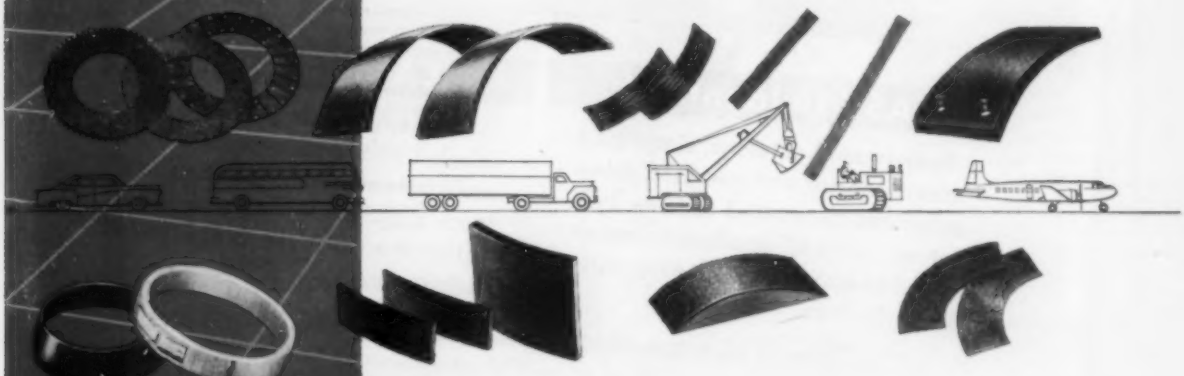
Johns-Manville engineers and scientists unveil new research facilities especially created for the development of high performance J-M Brake Linings and Clutch Facings

THIS HUGE inertia dynamometer—*left*—is only one of the many outstanding features of the new Johns-Manville laboratory at Manville, N. J. Along with other precision units, its research facilities promise completely new standards for measuring and improving the effectiveness of friction materials of every type and for every purpose . . . now and for the future!

Whether the problem involves checking the clutch of a small power mower or a huge diesel shovel—or the brakes of a car, bus, truck, machinery or plane—the sensitivity and accuracy of this new equipment broadens the opportunity for the investigation, evaluation and development of high quality, high performance J-M Brake Linings and Clutch Facing.

The recognized leader in Friction Material development for 70 years, today Johns-Manville produces materials that are specified and used as standard original equipment on many leading makes of new automobiles, trucks, buses and industrial units. They are economical and dependable . . . provide stabilized friction for longer periods under grueling pressures and temperatures, withstand heavier shock loads and faster rubbing speeds.

The Johns-Manville engineering staff and the world's best equipped friction material development laboratory are at your service. Your Johns-Manville representative will gladly tell you more about this service . . . or write to Manager Automotive Division, Johns-Manville, 22 East 40th Street, New York 16, N. Y.

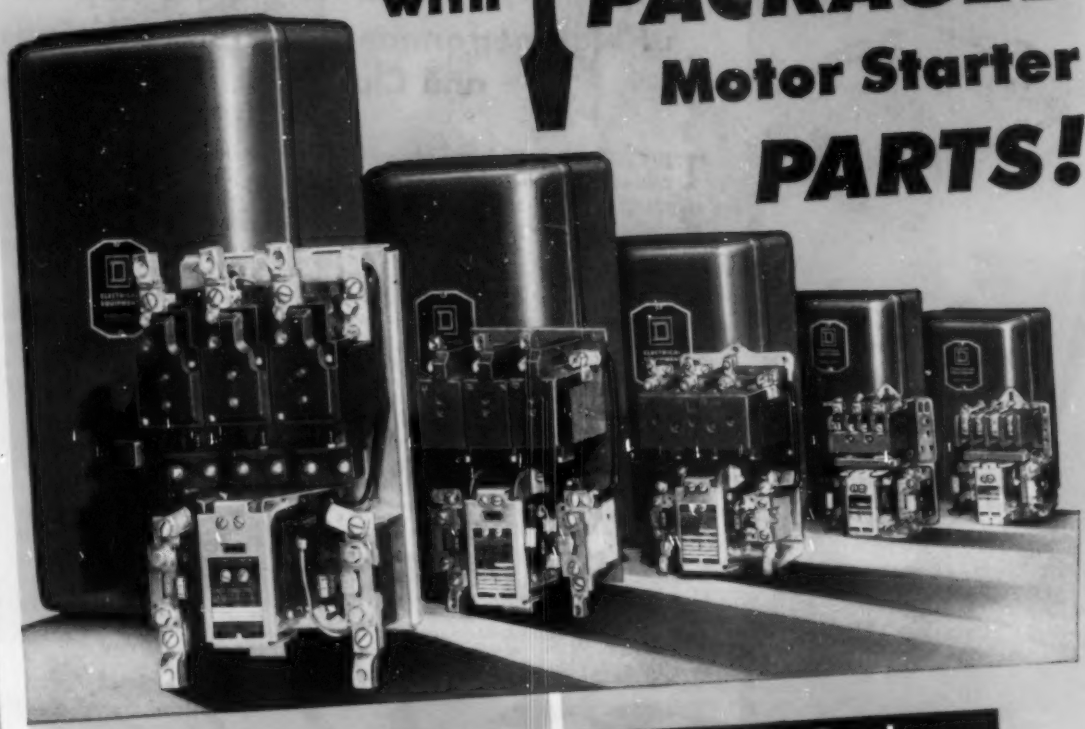


FRICTION MATERIALS

JM PRODUCTS

Qwik Change

with **PACKAGED Motor Starter PARTS!**



EASY to Identify!

Easy-to-read catalogs, simplified motor control and overload relay selectors, illustrated service bulletins...these all combine to assure *quick changes* through easy parts identification.

EASY to Buy!

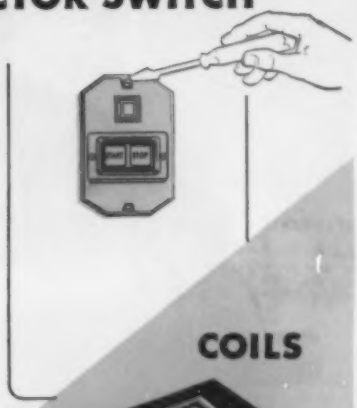
Conveniently packaged and labeled conversion parts are immediately available "off-the-shelf" from a nationwide network of authorized Square D electrical distributors.

Write for Bulletin 9999. Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin.

SQUARE D COMPANY

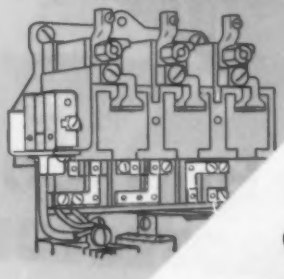
NEW PUSH BUTTONS AND SELECTOR SWITCH

These Kits contain all parts necessary to make quick changes from standard starters to either push button or selector switch controlled devices.

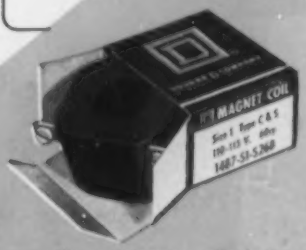


INTERLOCKS

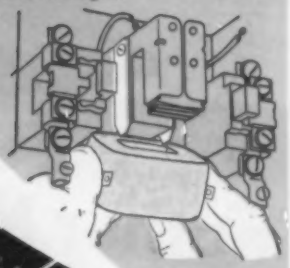
A wide variety of quick-change, front-mounted interlocks adds flexibility for special applications.



COILS

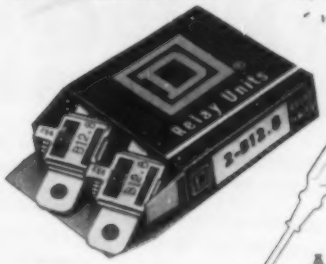


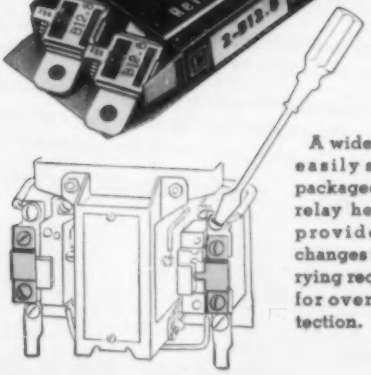
Screwdriver is only tool required for quick change of magnet coil to accommodate different voltages.



Faster to Install

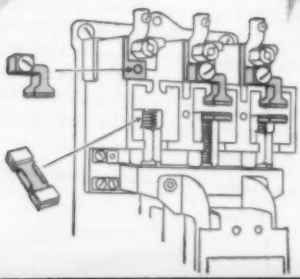
O.L. RELAYS





A wide variety of easily selected, packaged overload relay heater units provides quick changes to meet varying requirements for overload protection.

CONTACTS



Packaged replacement contacts are easily installed without disturbing wiring.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

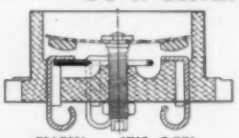
Another Motor that won't burn out

...it's protected by a built-in KLIXON PROTECTOR

No sir... not the motor illustrated, because the motor manufacturer provided inherent overheat protection by building-in a Klixon Motor Protector.

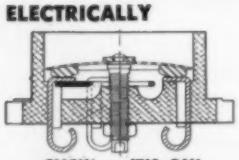
As a user of electrical motors, you can keep your equipment operating longer, cut motor repair and replacement costs by specifying and using motors with built-in Klixon Protectors. The additional cost is low... pays for itself in short order.

DO IT BETTER — DO IT ELECTRICALLY



CLICK!... IT'S OFF!

Should a motor become overheated and dangerously hot, the Klixon Protector snaps the power "off" preventing the motor from burning out.



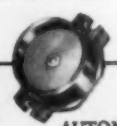
CLICK!... IT'S ON!

When the motor cools to safety, the Klixon Protector snaps the power "on" automatically, or by pushing the red button when the manual reset type is used.

MANUAL RESET

KLIXON

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
910 FOREST ST., ATTLEBORO, MASS.



AUTOMATIC RESET

KLIXON
PROTECTORS HELP MAKE EVERY WEEK NATIONAL ELECTRIC WEEK

Motors help everybody do things electrically — KLIXON protectors help motors do it better by keeping them working safely at maximum safe loading conditions, and by preventing burnouts under unsafe conditions.

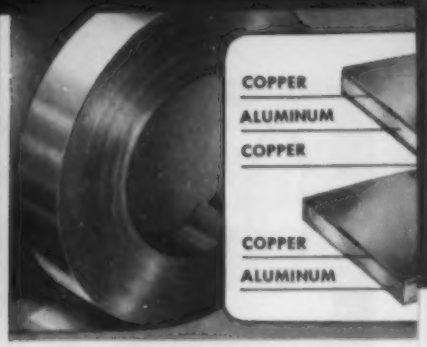
NATIONAL ELECTRIC WEEK OCTOBER 18-24, 1954

TRUFLEX THERMOSTAT METALS

TRUFLEX thermostat metals are manufactured in a wide variety of types, each with a different reaction to temperature. Uniformity of metal insures accurate and consistent performance. Precision parts fabricated to exact specifications.

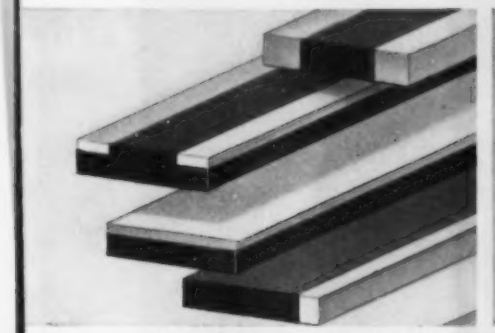
COMPOSITE METALS

Available in practically any combination of precious to precious, precious to base or base to base metals. Combinations for electronics include aluminum-clad iron, nickel-clad iron for anode materials.



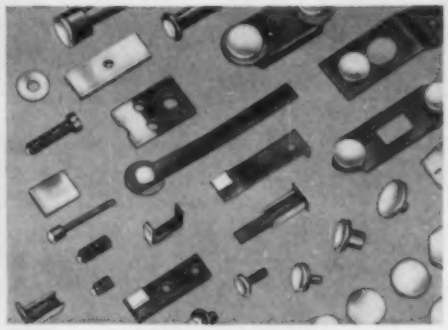
ALCUPLATE

Copper-clad aluminum for component cases or cans, chassis, cooling fins, etc., light weight, excellent conductivity. Copper surface is ideal for soft soldering and electroplating.



COMPOSITE CONTACT MATERIAL

Precious metals and alloys bonded to base metals available in following types — overlay, single and double edgelay, single and double inlay, Top-lay, ready for you to fabricate into contacts.



COMPOSITE CONTACTS

General Plate can supply all types of fabricated composite contacts, buttons, rivets, contact assemblies made to customer's specifications. These contacts give electrical conductivity and long life at reduced costs.

WAVE GUIDE and COLLECTOR RINGS

RECTANGULAR WAVE GUIDES. Solid silver, silver lined brass or aluminum. Sizes to government specifications.
COLLECTOR RINGS. Solid silver or precious metal on base metal. All sizes.

General Plate Products
that solve your Design Problems

General Plate Composite Metals, made by metallurgically bonding one metal to another, are available in sheet, strip, tubing or wire in various widths, thicknesses and diameters.

Silver, gold and platinum-group metals bonded on base metals give solid precious metal performance at a fraction of the cost of solid precious metal. The precious metal provides specific performance requirements such as electrical conductivity and corrosion resistance while the base metal provides workability, strength, and solderability.

Composite base metals provide a new group of engineering metals with properties not available in solid metals. Their use frequently results in lower material costs as compared to solid metals.

In many electronic applications further economy results when General Plate supplies fabricated parts ready for assembly into your product. General Plate makes an infinite variety of fabricated parts, such as electrical contacts, collector rings and TRUFLEX thermostat metal parts to customer's exact specifications.

General Plate Engineers will gladly help you with your problems.

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION

110 FOREST STREET
ATTLEBORO, MASSACHUSETTS

You can profit by using General Plate Composite Metals!

- **Alnifer®, Nifer®** — Aluminum and Nickel-clad steel for anode plates.
- **Alcuplate®** — Copper-clad aluminum for component cases, chassis, cooling fins, condenser blades, etc.
- **Alsiplate®** — Silver-clad aluminum for lightweight condensers, etc.
- **Composite Contacts and Contact Materials** — Increased strength and longer life at reduced cost.
- **Collector Rings** — Fabricated from solid precious metals or precious-clad base metals. Sizes ranging from fraction of an inch to few feet in diameter.
- **Truflex® Thermostat Metal** — Sheet strip, formed elements and assemblies produced to specification.
- **Thin Gauge Metals** — Beryllium copper, nickel, pure beryllium, Haynes Stellite alloys, etc.
- **Platinum-Group Metals** — Sheet, wire, tubing, parts of all types. Complete assay and refining facilities for platinum-group metals.
- **Silver and Gold Brazing Alloys** — Available as sheet, wire, powder and fabricated parts.
- **Bondwich** — Solder-clad brazing shim for carbide-tipped tools.
- **Bronco** — Phosphor Bronze-clad copper for high conductive springs.
- **Conflex** — Copper-clad spring steel for electrical and thermal conductive springs at low cost.
- **#720 Manganese Age-Hardening Alloy** — Corrosion resistant spring material for diaphragms, springs, finger stock, etc.
- **Rectangular Wave Guide Tubing** — Wide range of sizes to government specifications.

Write for catalog PR700.

Contact KAYDON Muskegon

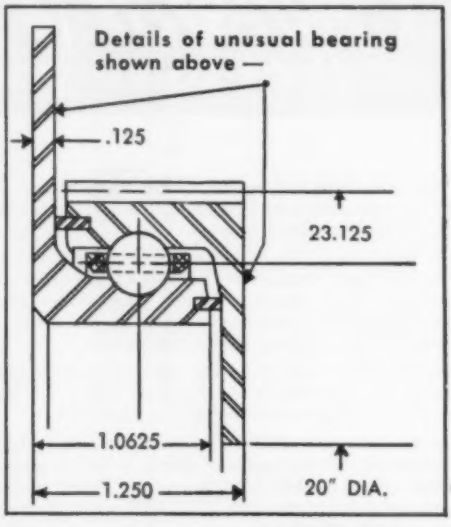
FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER

EXTRAORDINARY, THIN-SECTION BEARINGS . . . AN EVERYDAY ASSIGNMENT FOR KAYDON ENGINEERS

This special, thin-section bearing is typical of the outstanding job KAYDON does to solve tough bearing design problems. Bearings of this particular type are currently being adapted by KAYDON for a host of aircraft, radar equipment, and guided missile applications. Check the sketch at the right. Note the unusual 1/8" flanges and the fact that the gear teeth extend through only 130°. Then, too, this bearing features integral seals which are built into the bearing.

When you're faced with a difficult problem involving special bearing design, take advantage of KAYDON's specialized experience in developing and mass-producing thin-section and special high-precision bearings. Write, wire or phone. A KAYDON expert will be pleased to cooperate, help you get the job done faster, better and probably at less cost.

Just Out! Get your copy of the new KAYDON Reali-Slim thin bearing catalog No. 54.



KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

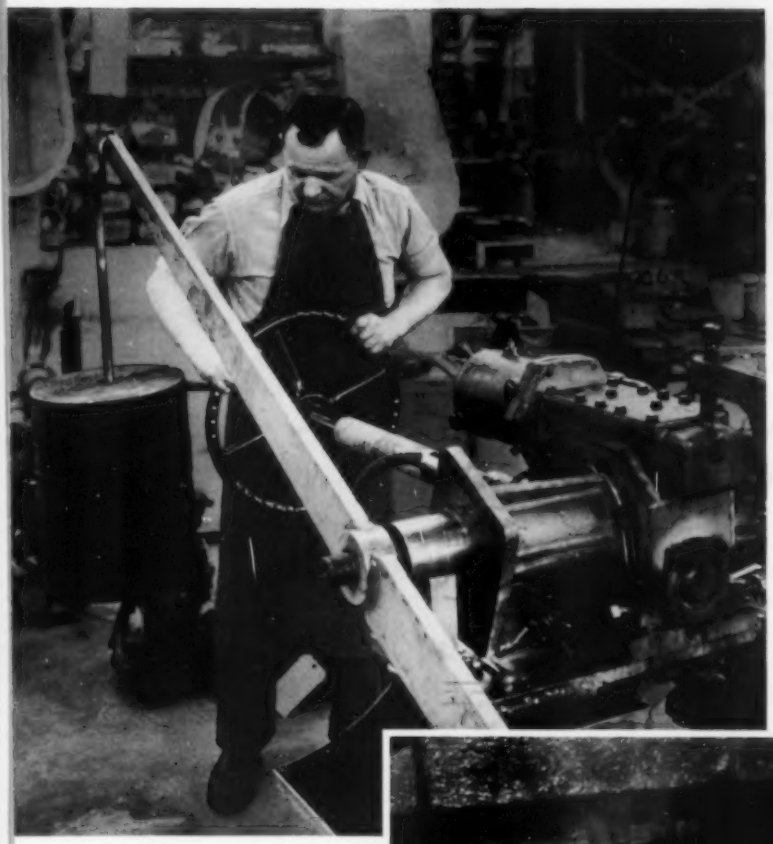
K542

PRECISION BALL AND ROLLER BEARINGS

New facts for your file on

USS CARILLOY STEELS

USS Carilloy steels minimize distortion in power steering units for cars

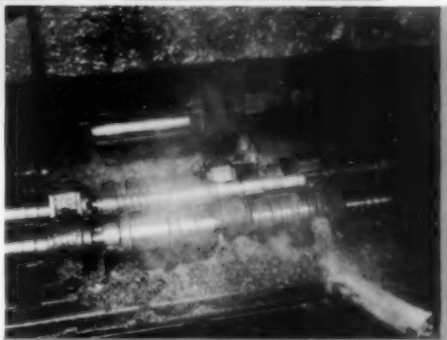


Torque Testing of completed steering unit. Even the heaviest steering loads require only 3 lbs. pull by the driver of an automobile with power steering. In addition, road shocks are cushioned by the power steering unit.

POWER steering units are precision machines. Every part must fit exactly. Parts must be interchangeable. They must be made to finished tolerances as small as .0001". They must be heat treated with minimum distortion.

These rigid requirements dictate the use of accurately controlled *alloy* steels that can be *quenched in oil*. These steels must respond uniformly to heat treatment, time after time, so that many thousands of parts can be made —*all exactly alike*. USS CARILLOY steels are used extensively in power steering units because they help to insure the uniformity that is essential in all critical parts.

CARILLOY steels are giving excellent service daily in a wide variety of precision parts for automobiles, aircraft, trucks, farm equipment, construction machinery, rotating machines, and many other applications. These high quality steels are meeting some of the toughest requirements known to industry. They can meet yours. For information write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.



Worm Shafts are ground to within .0005". Alloy steel must be used for these parts so they can be quenched in oil with a minimum of distortion to maintain the close tolerances.

Heat Treatment. USS CARILLOY steels have the uniformity in response to heat treatment that is so necessary to obtain the high strength, adequate ductility and minimum of distortion required in power steering units.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO

TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST

UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on

USS HIGH STRENGTH STEELS

Roof purlins of USS COR-TEN steel are 28% lighter, cost 17.5% less than carbon steel

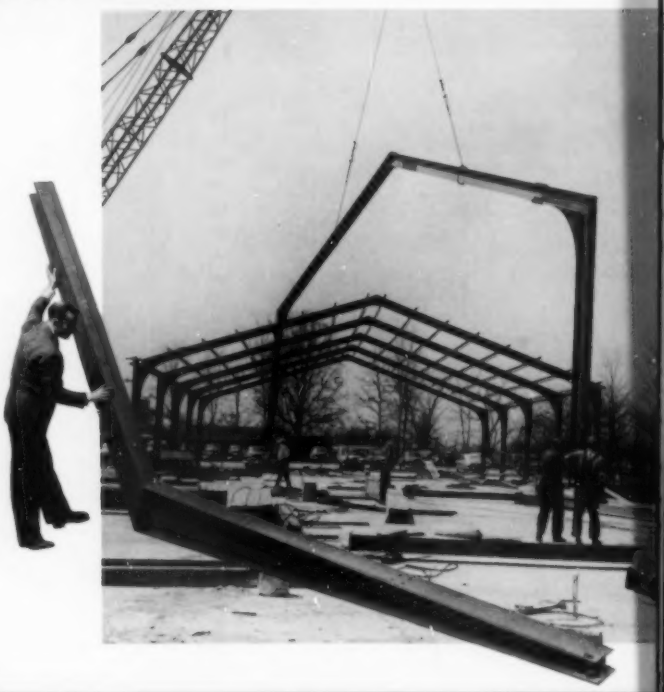
● By taking advantage of the higher strength of USS COR-TEN steel, The Steelcraft Manufacturing Company, Rossmoyne, O., manufacturers of Standard Steel Buildings, was able to substantially reduce both the weight and the cost of the purlins used in the rigid-frame steel buildings they have made for the U.S. Government and for commercial and industrial use.

Although the 20-ft. purlin sections made of 14 gage USS COR-TEN steel have the same load carrying capacity as 12 gage carbon steel, they are 30.4 lbs. lighter and cost $2.63 less each.

The manufacturer estimates that the rigid-frame construction itself reduces cost about 20% when compared to conventional construction, and when COR-TEN steel is used, costs are still further reduced about 25%.

USS COR-TEN steel also ensures other important economies. Its lighter weight not only makes handling and assembly easier but materially reduces freight costs, both when the steel is shipped from the mill and again when the building sections are transported to the erection site.

Because COR-TEN steel has 4 to 6 times the resistance to atmospheric corrosion as carbon steel, and because paint adheres more tightly to it, the COR-TEN steel purlins will outlast ordinary steel construction and require minimum maintenance through the years.



USS MAN-TEN steel reduces weight, assures greater strength and durability in Cardwell "Trailerig"

● Extreme portability which keeps moving costs to a minimum is obtained in this well-known portable oil drilling rig which combines the draw works assembly, including the mast, with the trailer frame.

This compact, completely unified machine has capacity for 5,000 foot slim hole drilling and 10,000 foot workover. It carries a 90- or 96-foot mast which can be telescoped and folded down so that the "Trailerig" in roading position is only 8 feet wide, 13½ feet high and 59 feet long.

To keep weight as low as possible without sacrificing ruggedness, the Cardwell Mfg. Co. of Wichita, Kansas, has built the bridge-type trailer frame and working platform of high strength USS MAN-TEN steel and reduced weight 6,000 lbs. as compared to carbon steel construction.

Additional weight has been saved in the mast in which all structural members are of 8" x 11.5 lb. MAN-TEN steel channels. These are considerably lighter than if carbon steel of equal strength had been used.

But USS MAN-TEN steel does more than save weight in this construction. Its higher fatigue strength—40% greater than carbon steel—and its greater strength and abrasion resistance pay off in increased durability which minimizes maintenance and helps to keep the "Trailerig" steadily on the job when making hole.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

Stainless Steel milk dispensers fabricated at rate of 120 units per day

BY UNITED REFRIGERATOR

The experience of United Refrigerator Company, Hudson, Wis., shows how adaptable Stainless Steel is to mass production operations. Milk dispensers—used for serving cold milk in glasses in schools, restaurants and the armed services—are being fabricated from Stainless Steel at a rate of more than 120 units per day.

United uses no special equipment in fabricating Stainless Steel. Such operations as shearing, punching, notching, braking, soldering, spot welding and grinding take place on equipment used for fabricating mild steel.

Shop practices are much the same, too. Blades are kept a little sharper, dies a little smoother and greater care is exercised to prevent marring the smooth surface of Stainless.

The result is a product with a high degree of sales appeal . . . made from a material perfectly suited for the sanitary nature of the application.

Stainless Steel milk dispensers after assembly at United Refrigerator Company.

Stainless Steel is not difficult to fabricate -it's just different

You pay no penalty in shop procedure to obtain the outstanding sales benefits of Stainless Steel. You can usually use the same equipment used for carbon steel with the addition of a little more power and a little more care.

So put Stainless Steel into your designs and into your selling. Our representatives will be glad to help you select the proper grade and fit it to your fabricating procedure.

Polishing the inside of a 30-quart bowl at ACF Industries.

Mixing bowls –12 to 160 quarts– drawn from Stainless Steel

ACF Industries, at its Milton, Pa. works, fabricates a line of industrial mixing bowls used by bakeries, restaurants, chemical plants, cosmetic manufacturers and the like. Depending on service conditions, the bowls are of carbon steel or Stainless Steel. But the same fabricating equipment is used for both.

Fabrication of a 30-quart Stainless bowl begins with two draws on a 1000-ton hydraulic press. The 31½" circle is first reduced to 20" and then to 14½" making a bowl 15" high. Stainless used is 16 gage.

The bowl is then annealed and pickled, the flange is trimmed, it is spun and beaded on a lathe, the outside is polished, handles and fittings are welded on and the inside is polished.

Even dies are used interchangeably between carbon and Stainless. Stainless requires only a little more careful handling.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

How the use of NATIONAL Seamless EXTRUDED Stainless Tubing *cuts nut manufacturing costs*

USING NATIONAL Seamless EXTRUDED USS Stainless (type 303) Tubing, the Tri-Clover Division of Ladish Corporation is now turning out hexagonal nuts in less time and at lower cost than they could using solid bar stock. The savings in material cost alone amounts to 11.77 cents per piece.

All machining on the nuts, except threading and O.D. finishing, is done in one operation on a 6-spindle, 3½ inch Conomatic automatic machine. A saving of five seconds in the time cycle was made by using the extruded hexagonal stock versus bar stock. The use of hex tubing has eliminated the cost and upkeep of boring tools—and, because tubing is considerably lighter than bar stock, it can be handled faster and with less difficulty.

NATIONAL EXTRUDED Tubing offers you high strength, uniformity, and dependability that only *seamless* tubing can give. For a better precision part, involving fewer operations and fewer machine hours, investigate NATIONAL Seamless EXTRUDED Tubing—made by the world's largest manufacturer of tubular steel products. Feel free to call our engineers if you'd like help in applying NATIONAL Seamless to your product.

* * *

National Tube employs a hot-extrusion process known as "Sejournet" in which white-hot billets of steel are squeezed into tubing of various shapes by a 2,500-ton hydraulic press and ram—a manufacturing method that insures absolute uniformity of wall strength.

NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL Seamless EXTRUDED TUBING

WALLS WITHOUT WELDS

UNITED STATES STEEL

Keeping chemical cars from cooling

Here's a job that's really man-sized! The worker above is insulating a whole chemical tank car with fibrous glass. His job of attaching this heavy-duty material to the metal surface of the car is a lot easier now than ever before—thanks to a 3M adhesive. It used to take a lot of time and patience to attach the insulation using straps and clamps. Now one man can do the entire job in short order with a minimum of effort. The adhesive is brushed on to the tank car, the insulation is pressed into contact and cut to size. That's all there is to it!

As a result, warm chemical solutions can be shipped without losing their valuable heat, allowing chemical concentration to be kept at a high level while in transit.

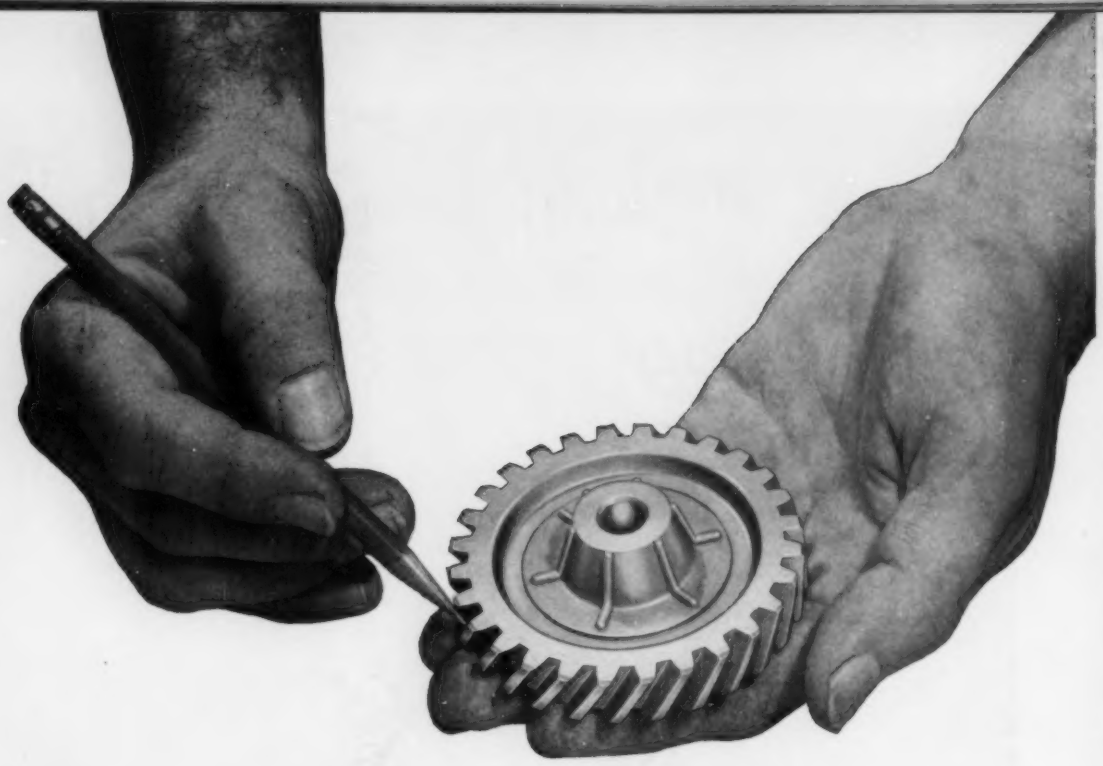
See what adhesives can do for you . . . For your man-sized jobs, or little ones . . . look into 3M adhesives for the efficient, *practical* method of fastening. Your 3M sales representative will be glad to consult with you. Call him in. And, for a free, informative booklet, write today to 3M, Dept. 410, 417 Piquette Ave., Detroit 2, Michigan.

see our catalog in PRODUCT DESIGN FILE or write for copy

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE. DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N. Y. 17, N. Y. • CANADA: LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS



they thought this die casting couldn't be made...

● But **Stewart** turned out over 12,000 a week!

This helical gear is one example of an old habit at Stewart Die Casting—"finding a way." In 44 years, we have produced many castings that "couldn't be made." Whatever type of die castings you need—small or large, simple or intricate—count on *Stewart* to meet your most rigid specifications . . . on time.

SERVICES AVAILABLE . . .

Designing • Engineering • Die Making
Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.

44 years of helping industry to "Make It Better"

Stewart DIE CASTING

. . . a division of STEWART SW WARNER

CHICAGO, ILLINOIS, 4535 FULLERTON AVENUE • BRIDGEPORT, CONNECTICUT, 275 WARREN STREET

Heavy Duty Design

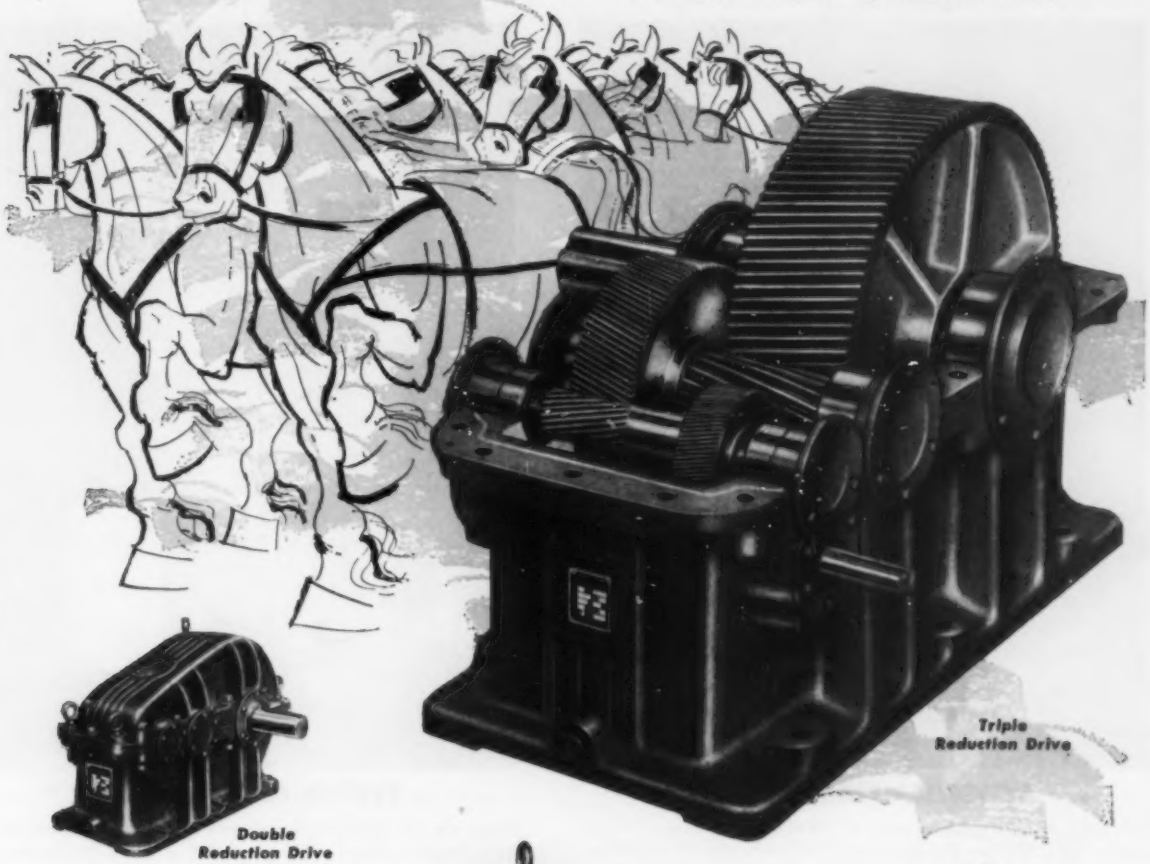
WITH MAXIMUM LOAD CARRYING CAPACITY

FOOTE BROS. MAXI-POWER DRIVES

Heavy Duty describes these tough, dependable drives perfectly! For these are the famous, job-proved units that were actually designed for only the hardest, most demanding daily service. Maxi-Power's precision generated helical gearing has been designed into the most *compact* housing possible to assure maximum load-carrying capacity in minimum space. Sturdy—reliable—with stamina to handle high horsepower—Maxi-Power Drives provide years of continuous service with minimum maintenance.

Foote Bros. Maxi-Power Drives are available with single, double or triple reductions, with ratios up to 360 to 1, capacities up to 1550 h.p. Remember, if you want heavy duty performance, you *need* Maxi-Power . . . there's nothing finer anywhere!

. . . learn how Foote Bros. Enclosed Gear Drives can meet your needs for toughest daily service. Write today!



Triple Reduction Drive

Double Reduction Drive

Line-O-Power Drive
Incorporate higher capacity, space saving, longer life Duti-Rated Lifetime Gears. Available in double and triple reductions with ratios from 5 to 1, up to 238 to 1; capacity range from 1 up to 200 h.p.

FOOTE BROS.

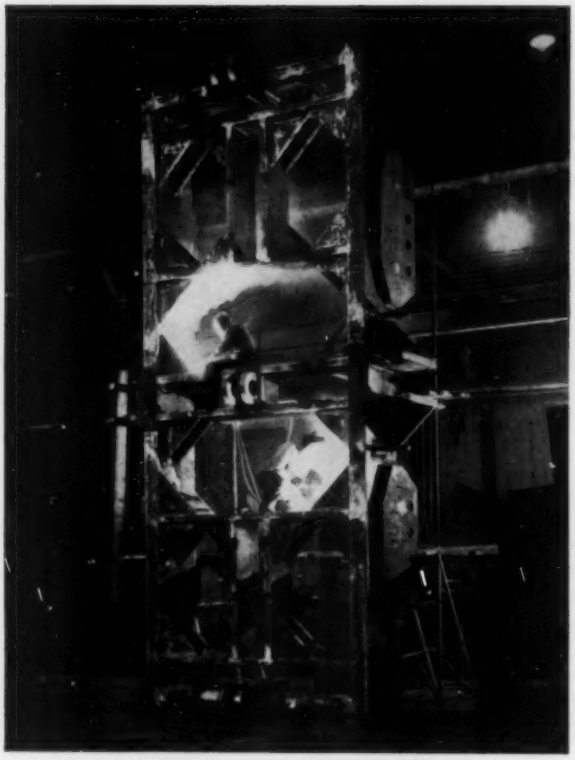
Better Power Transmission Through Better Gears

Manufacturers of Duti-Rated Lifetime Gears, enclosed gear drives of all kinds, gearmotors, aircraft-quality gears and actuators, and special machinery . . . the world's finest since 1859.

FOOTE BROS. GEAR AND MACHINE CORPORATION • 4545 SOUTH WESTERN BOULEVARD • DEPT. W • CHICAGO 9, ILLINOIS

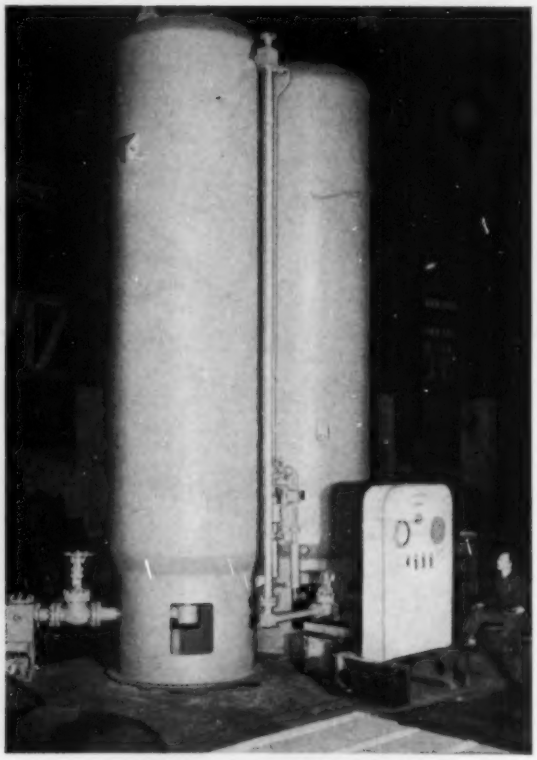
100-FT WELDED GIRDERS—More and more, welding is coming into its own in heavy construction work these days. For instance, the designers called for twelve of these all-welded girders for a bridge on the New York State Thruway, one of the biggest highway projects in the East. Each girder is 4½ ft deep, with 18-in. flanges. They were largely semi-automatically welded, and all critical welds were radiographed.

WHAT'S NEW IN WELDMENTS



WEIGHTLIFTING CHAMP

This hefty lifting beam was made to lift some of the biggest ingots made — up to 275 tons. The beam itself weighs a healthy 37 tons. Some of the plates you see here are as thick as 7 in. This beam is a good example of the many types of jobs that can be done best by welding.



TESTED TO 1300 PSI

These are the hydro-pneumatic accumulators for a powerful press. Made to operate at 650 psi, their 2-in.-thick, 73½-in.-diam shells were welded, stress-relieved and radiographed here at Bethlehem. They stand 27½ ft tall, weigh a total of 50 tons.

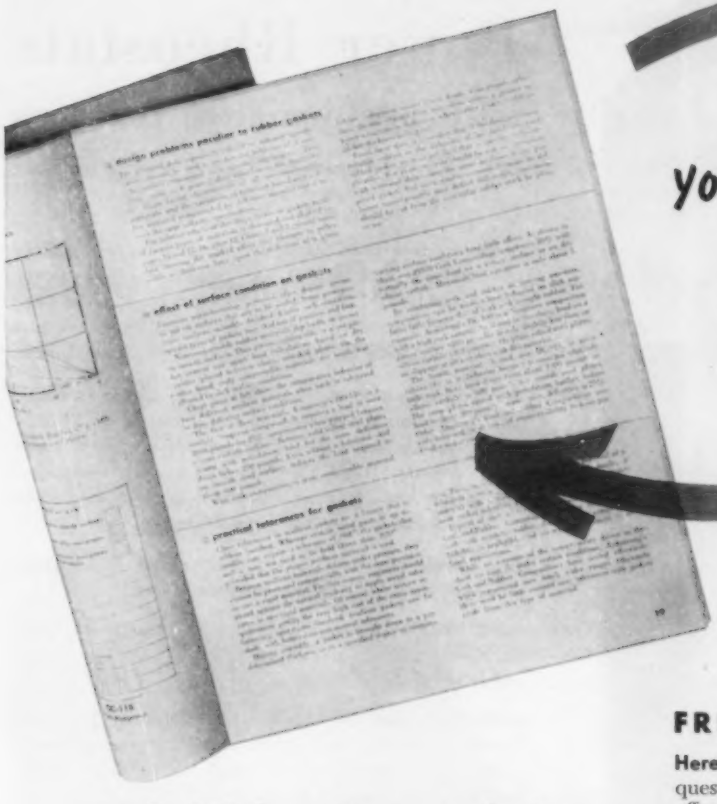
For further information about Bethlehem Weldments, write or call the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

How can flange surface conditions cause poor gasket performance?



you'll find the answer in this newly revised gasket manual

17 helpful sections, including:

- **Designing flanges for efficient sealing**
- **Sealing with confined resilient gaskets**
- **Designing gaskets to reduce costs**
- **Effect of gasket width on compression**
- **Relation of gasket thickness to load**
- **Design problems peculiar to rubber gaskets**
- **Effect of surface conditions on gaskets**

FREE FOR YOUR FILES

Here's a helpful, 24-page manual that answers questions like these: How can flange surfaces affect gasket performance? What Armstrong materials meet today's SAE-ASTM and U. S. Government gasket specs? What tolerances are practical for resilient gasket materials? "Armstrong's Gasket Materials," newly revised for 1954, is prepared especially for the gasket or gasket-design field. Includes latest data on gasket, flange, and joint design. See it in Sweet's product design file, section 3h, or mail the coupon for a free copy.

SEND COUPON TODAY

Armstrong Cork Co., Industrial Div.,
7110 Irvin St., Lancaster, Pennsylvania

Please send me your new 24-page gasket manual.

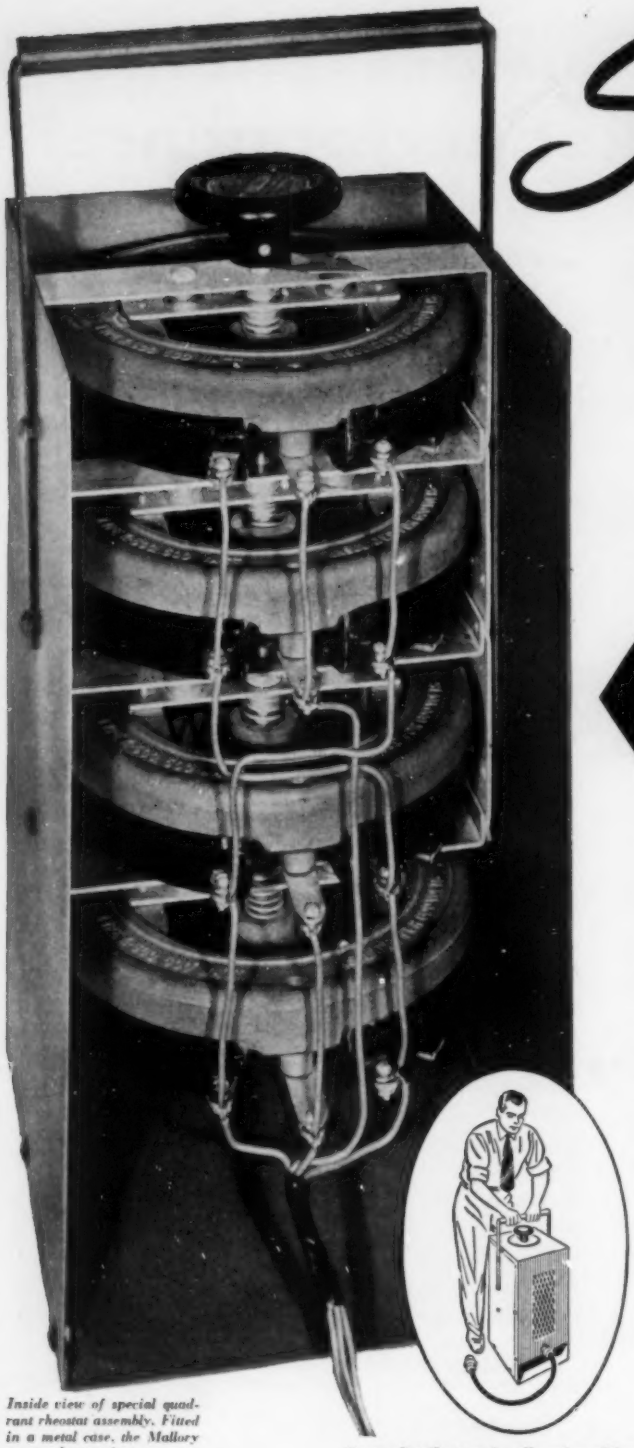
Name _____

Company _____

Address _____

_____ *Position* _____

ARMSTRONG'S GASKET MATERIALS



Inside view of special quadrant rheostat assembly. Fitted in a metal case, the Mallory power rheostat is a compact, easily carried unit.

Special

Power Rheostats

with performance features of Mallory "standards"

Need a power rheostat of specialized design? Mallory can engineer and build it to your exact requirements, using standard Mallory rheostat units modified to your needs, and assembled into a complete package that does the job you want in the way you'd like to have it done.

Here's a typical example—a four-section 2000-watt rheostat designed and manufactured by Mallory for the Louis Allis Company. Housed in a sturdy ventilated cabinet made by the Louis Allis Company, the Mallory power rheostat is readily portable for laboratory testing of large DC motors.

Into these "specials" go all the proved performance values of standard Mallory rheostats:

LONG SERVICE LIFE . . . highly stable ceramic materials insulate current carrying parts . . . design allows ample ventilation.

ACCURATE TAPERS . . . produced by Mallory-developed precision winding techniques, including variable-pitch winding to produce special tapers with a single, long-lasting wire.

HINGED CONTACT ARM . . . a Mallory "first" in design, eliminates loss of spring pressure from overheating, because the spring carries no current . . . permits cleaning and brush replacement without danger of changing contact pressure.

Whatever may be your needs in power rheostats, Mallory is thoroughly prepared to meet your specifications for either standard or special types. For complete details on all Mallory rheostats and vitreous enamel resistors, write today for your copy of our new catalog.

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

The case of the

BEAUTIFUL FRAME

A well-known handbag manufacturer who'd been having a problem getting a beautiful finish on brass frames at a low production cost called on Bridgeport's Technical Service for assistance.

Here's the case history: After careful study of his problem, a Bridgeport Fine Grain Brass — *custom made to the exact grain size best suited to the manufacturer's requirements* — was recommended. This vanity case quality metal was selected because the fine grain surface needs little finishing and the brass works well. Look at those 90° bends, for example, and notice how the brass is stiff enough to hold the cloth of the bag by itself.

By using Bridgeport Fine Grain Brass and improved techniques, a beautiful, lustrous finish was attained and *production per man in the finishing department increased five times.*

This is another case history to prove that *no single fine grain brass can do all jobs well.* A whole range of fine grain sizes is available, and since there is no one pat answer for all finishing problems, Bridgeport recommends the exact fine grain size only after consideration of all factors.

To find out how Bridgeport can help you improve your product and lower manufacturing costs with the right metal for your needs, call your nearest Bridgeport Sales Office.

Write for a free copy of Bridgeport's folder on Grain Size — "The Fourth Dimension."

Handbag product of The Randolph-Rand Corporation, New Rochelle, New York.

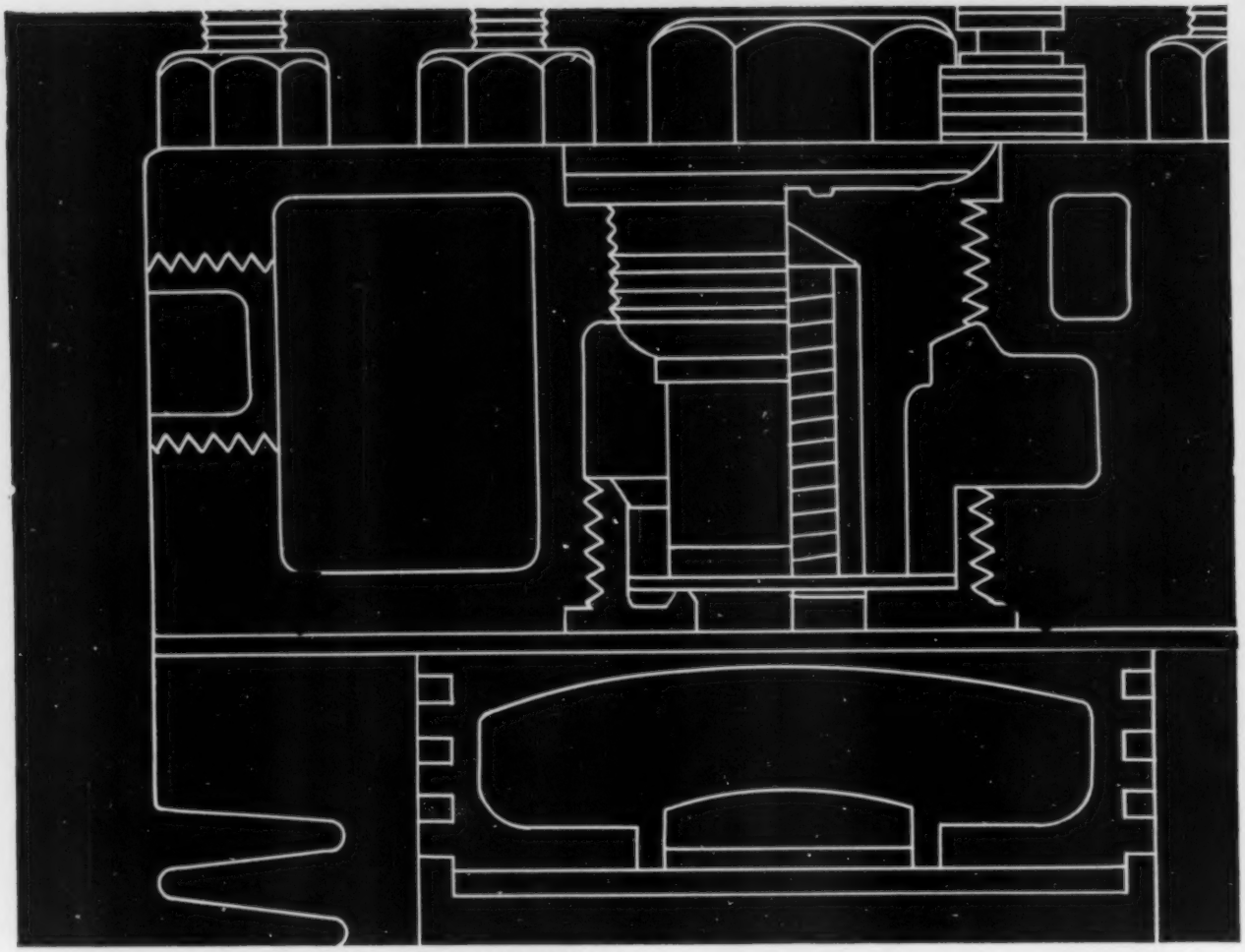
BRIDGEPORT BRASS COMPANY ◆ BRIDGEPORT, CONNECTICUT

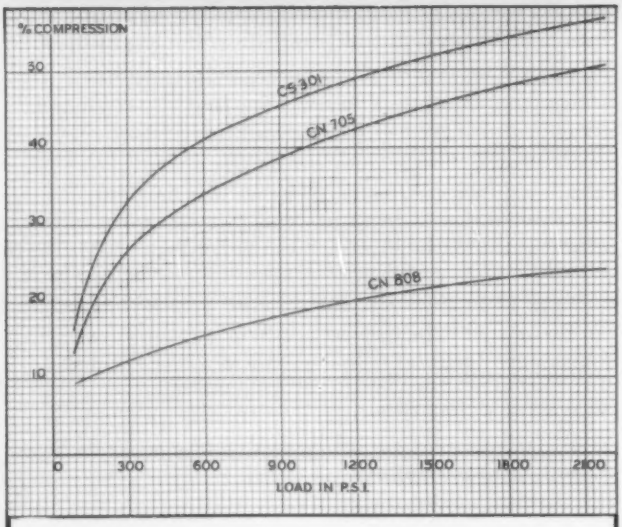
Serving Industry With a Network of Conveniently Located Sales Offices and Warehouses

Mills at Bridgeport, Conn., Indianapolis, Ind., and Adrian, Mich.

In Canada: Noranda Copper and Brass Limited, Montreal

Visit Bridgeport's booth 1015 at the National Metal Exposition in Chicago, November 1-5.





ACCOPAC'S HIGH COMPRESSIBILITY is shown clearly by these load-compression curves. With light or stamped metal flanges, this compressibility allows gaskets to conform to irregularities and to seal without distorting the flange. On heavy flanges, Accopac gaskets seal without crushing.

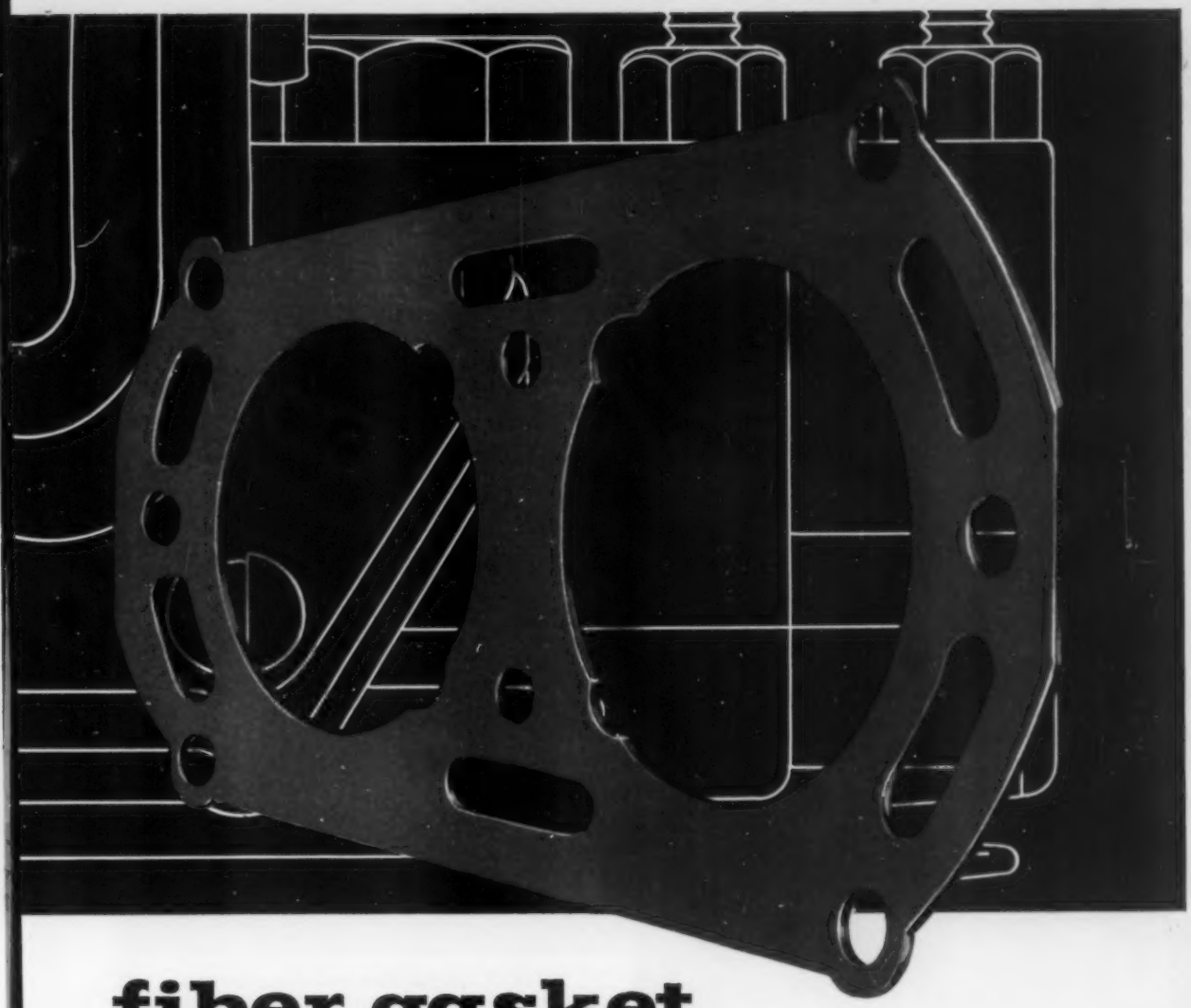
improved

keeps

When the manufacturer of an air compressor traced a loss in the compressor's efficiency, he found the difficulty in the cylinder head gasket. A conventional material that worked well in every other respect charred at the high operating temperatures, allowing air leakage.

Substituting an improved type of fiber gasket —Armstrong's CN-705 Accopac®—solved the problem. Accopac withstands temperatures up to 250° F. and gives long, dependable service without replacement.

Accopac seals tightly because of the way it's



fiber gasket

compressor efficiency high

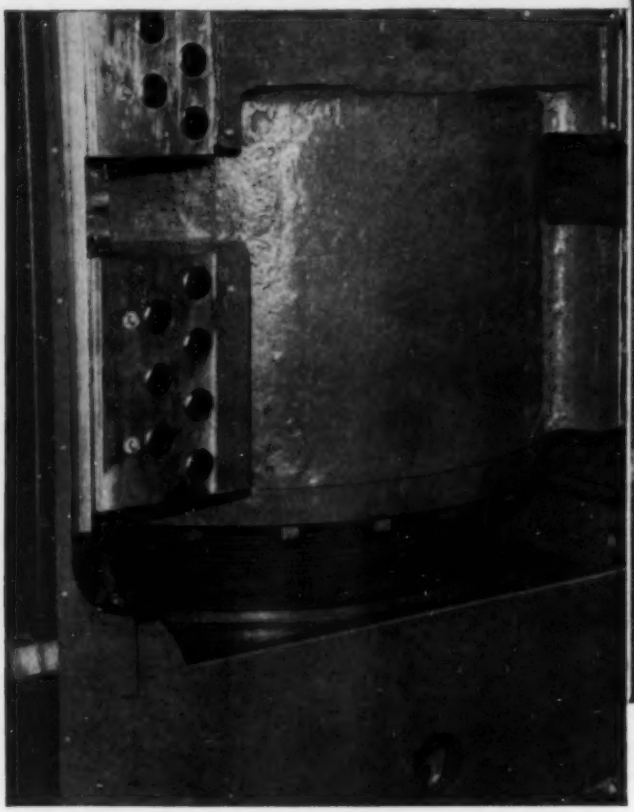
made. Fiber and cork are blended with a non-volatile, non-extractable latex binder in a special, patented beater saturation process. The resultant sheets are uniform, unusually compressible, and resistant to dimensional change under varying humidity and temperature conditions.

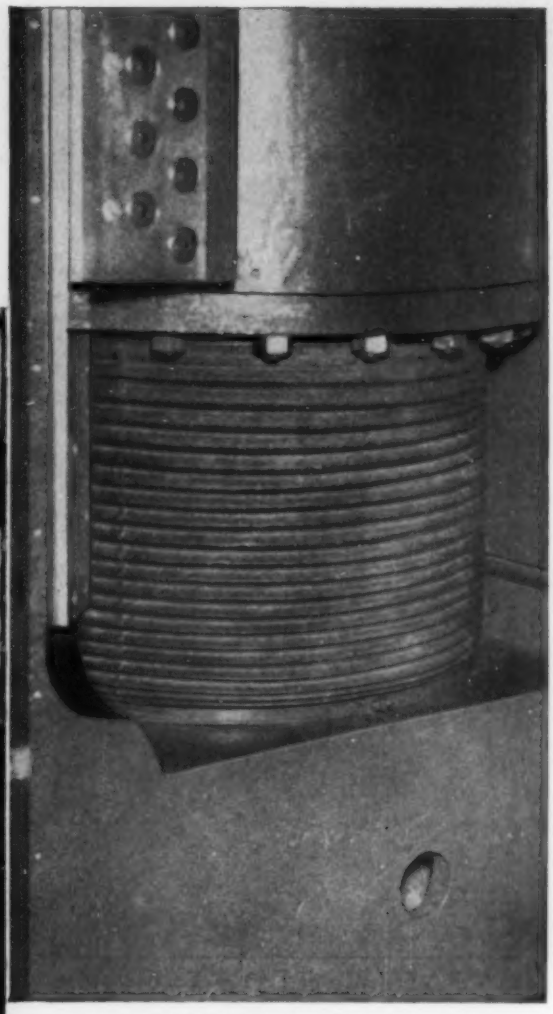
If you're looking for stability and strength in a dependable, low-cost gasketing material—investigate Accopac. It's being used today in pumps, aircraft devices, automotive equipment, household appliances, and a wide variety of other applications.

FREE 24-PAGE GASKET MANUAL—Look in Sweet's product design file for "Armstrong's Gasket Materials" . . . or write for your personal copy. Contains facts on Accopac and other efficient Armstrong's gasketing materials as well as information on gasket design. Write Armstrong Cork Co., Industrial Div., 7010 Irvin Street, Lancaster, Pa. **Be sure to specify Armstrong's Gasket Materials when you order from your gasket fabricator.**

ARMSTRONG'S ACCOPAC

New squeeze play with U. S. Multi-Flex Boots





Above is Multi-Flex Boot installed on a hydraulic press ram. Shallower, smaller corrugations mean less installation space necessary.

HERE are some new ideas about design versatility on protective boots. With Multi-Flex® products—a United States Rubber Company development—you can put entirely new advantages into equipment that requires protection for exposed moving parts.

Consider the U. S. Multi-Flex Boot. It completely shields the ram shown above from scoring by grit and other abrasives, yet occupies minimum installation space. Multi-Flex Boots meet travel requirements impossible in conventional boots. They also guard any precision-machine part—such as a piston, worm gear or adjusting screws. Custom made of rubber or rubber and fabric, they are produced without molds by this exclusive "U. S." process.

Multi-Flex Boots also are available in Silicone or Fiberglas constructions to handle temperatures from 65 degrees to 500 degrees . . . and are made to order in inside diameters from 1″ to 36″.

Machine tools, lift trucks, tractors, mining machinery, stamping presses are but a few of the many items that are now equipped with Multi-Flex. For engineering advice and assistance, get in touch with any of our 27 District Sales Offices or write to address below for a free copy of our Multi-Flex Catalog.

"U. S." Research perfects it
"U. S." Production builds it
U. S. Industry depends on it

US RUBBER

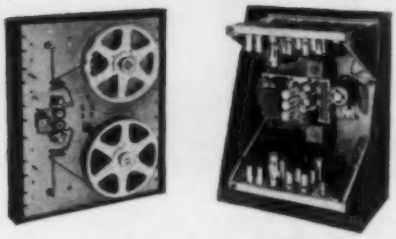
UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

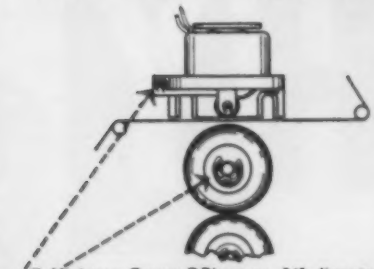
30 Waldes Truarc Rings Save Space and Time... Simplify Assembly and Disassembly

Potter's New Digital Magnetic Tape Handler



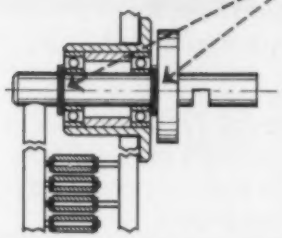
■ Prime requirements: fast starts, fast stops, fast tape speeds, great accuracy. Using Truarc rings, this new model starts and stops the tape within 5 milliseconds, has tape speeds up to 60 inches per second.

Solenoid Mount and Capstan Assembly



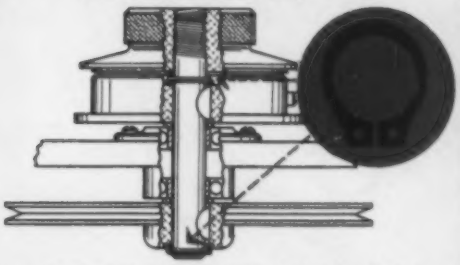
■ Miniature Truarc E-Rings on .040 diameter shaft and on continuously running capstans eliminate projecting bolts and screws. Rings permit rapid assembly and disassembly, fast replacement of worn rubber capstans.

Tension Shaft Assembly



■ Truarc E-Rings snap quickly into place, act as shoulders for the ball bearings with a minimum of friction. Additional Truarc Rings are used as spacers on shafts, can be located accurately to extremely close tolerances.

Reel Shaft Assembly



■ Truarc Standard Rings (Series 5100) hold the reel shaft assembly firmly in place and permit the use of quick-lock hubs so that the reel tapes can be changed in seconds as they are finished.

Potter Instrument Company, Inc., of Great Neck, L. I., uses 30 Waldes Truarc Retaining Rings in their new Model 902 High Speed Digital Magnetic Tape Handler. In addition to solving a variety of fastening problems, Truarc Rings facilitate the rapid acceleration and fast stopping needed in these machines.

Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Truarc Rings are precision engineered, quick and easy to assemble and disassemble. They save time and increase operating efficiency.

Find out what Waldes Truarc Retaining Rings can do for you, toward saving costs and improving your product. Send your blueprints to Waldes Truarc Engineers for individual attention without obligation.

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WALDES

TRUARC

REG. U. S. PAT. OFF

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WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,383,947; 2,392,940; 2,410,852; 2,420,021; 2,439,301; 2,439,705; 2,441,846; 2,455,165; 2,483,300; 2,483,303; 2,487,803; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!

PN106

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N.Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

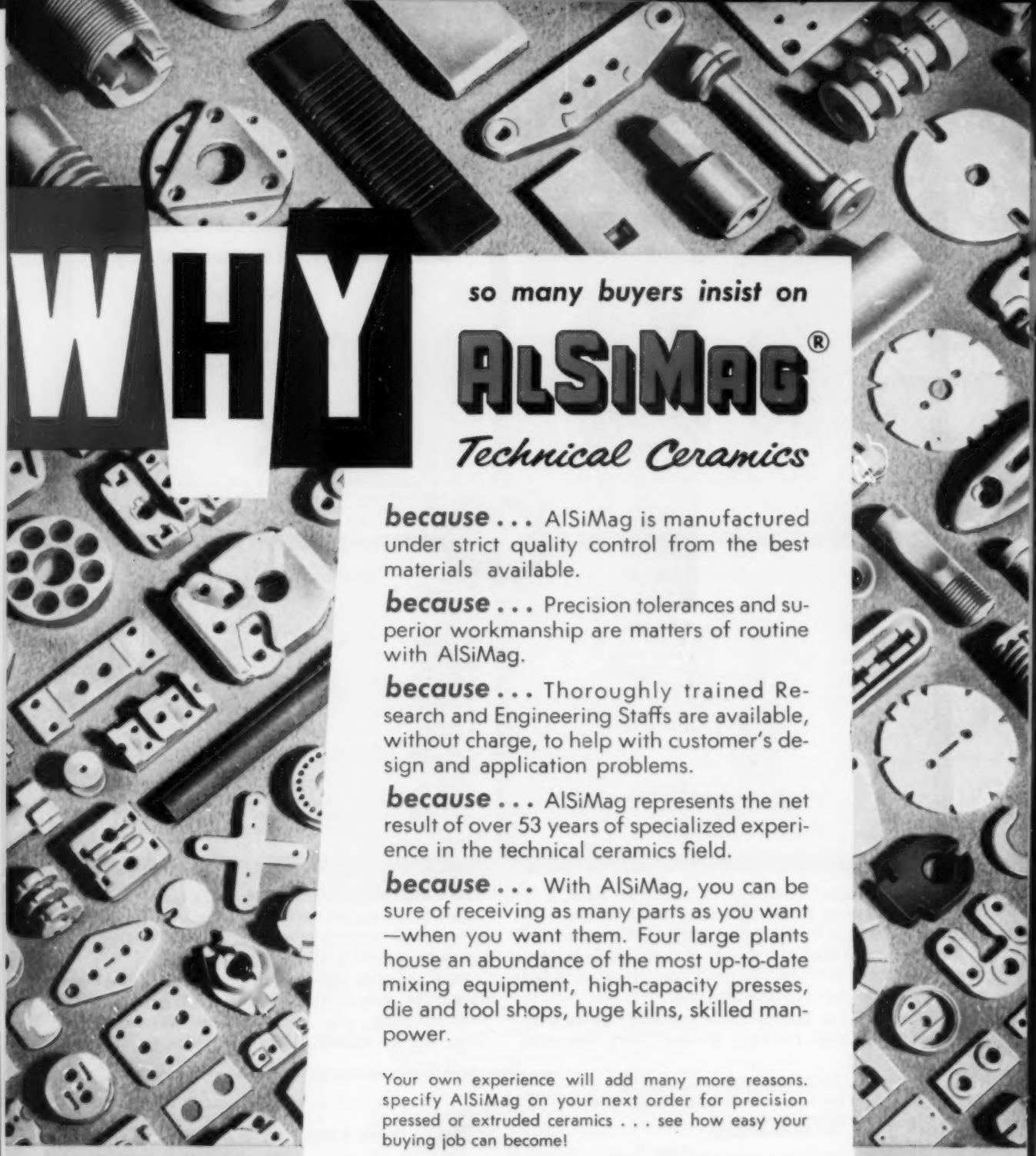
Name .....

Title .....

Company .....

Business Address .....

City ..... *Zone* ..... *State* .....



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Users praise Phillips Cross-Recessed-Head Screws

THIS BLOWER UNIT ON A BRYANT MODEL 315 OIL-FIRED FURNACE is powered by a ½ h.p. electric motor operating at 1750 r.p.m. "Were the screws that hold this assembly together to loosen," says John Zonza, foreman of the general assembly department, "the vibration would destroy the unit. *I do not know of a single instance where the Phillips screws have loosened during operation.*" John Craft here completes assembly of unit with Phillips screws.

CLARK CONTROLLER COMPANY uses Phillips screws in the manufacture of many of its highly specialized electrical control units. Inasmuch as the units are usually prominently located, neatness and compactness are of prime importance. "Certainly no one doubts that Phillips screws make a neater, more attractive appearance," states Carl W. Graber, Manager of Device Manufacturing. George Strickler, chief inspector, here gives Phillips screws a final check.

PERFORMANCE AND CONSTRUCTION STANDARDS FOR THE GRAY AUDOGRAPH necessitate the use of Phillips screws. "The better efficiency of these screws," states Al Jacobs, Chief Estimating Engineer, "results in speeded-up production that makes their selection automatic." Virtually no cuts, no accidents, no "head-splitting," no "burring," plus the use of power drivers are among Phillips screw advantages. Adeline Donahue here gives final electrical test to completed assembly.

MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY... AND OF THE FUTURE

X marks the spot

... the mark of extra quality

American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company Elco Tool and Screw Corporation • Great Lakes Screw Corporation • The H. M. Harper Co. • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Co. • Rockford Screw Products Co. • Scovill Manufacturing Co. • Shakeproof • The Southington Hdwe. Mfg. Company • Sterling Bolt Company • Wales-Beech Corp.

"Looks like everything you said, Jim"

"This is the spot I was telling you about, Ken. Good cover, good feed, lots of birds, not many hunters. Bill Brown and I got our limits here the other day. Boy, is he a terrific shot!"

"He was telling me about it too, Jim, and it sure looks like everything you said. Bill stopped in yesterday with prints on those aluminum extrusions Wolverine is making for us. Their Tubemanship is even better than Bill's marksmanship. I was certainly impressed with those prints. Did you ever see that Alabama plant of theirs—in Decatur?"

"No, but I've seen the pictures Bill has."

"They don't do it justice. When you see it for yourself you realize why it's called 'the world's most modern tube mill'."

"It's close to your southern branch, isn't it?"

"Less than 200 miles away. We do a lot of business with Bill. Not only in aluminum tube and shapes but in copper and copper-base alloy as well. For us dealing with Wolverine is like having two sources."

"Two sources. How do you mean?"

"Well, their Detroit plant is also one of the finest and we often order our welded steel tube there for our eastern plant."

"Say, that must save a lot of 'shopping around'."

"It does and in more ways than one. We like the completeness of Wolverine's facilities. We use a lot of tubing and they can meet our requirements. Sometimes we order plain tube; sometimes it's finned. Quite often we use their fabricated tubular parts."

"You know, Ken, Bill would get a real kick out of this. Here we are on his favorite hunting grounds talking about his favorite subjects—Wolverine and hunting."

"Terrific, isn't it. Let's be sure to tell him. Just in case he asks we better have some of those ring-neck pheasants to tell him about, too."

• • •

SURE AS SHOOTING: You can count on Wolverine Tube for the finest in copper, steel and aluminum tubing and extruded aluminum shapes. Write—right now—for your copy of the Wolverine Flow Chart. WOLVERINE TUBE, Division of Calumet & Hecla, Inc., 1479 Central Avenue, Detroit 9, Michigan.

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DIVISION OF CALUMET & HECLA, INC.

Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

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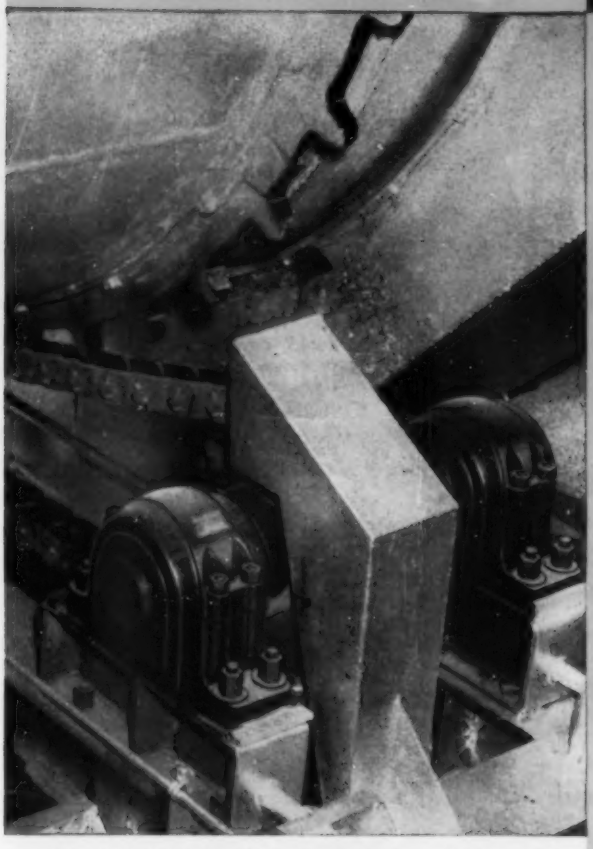
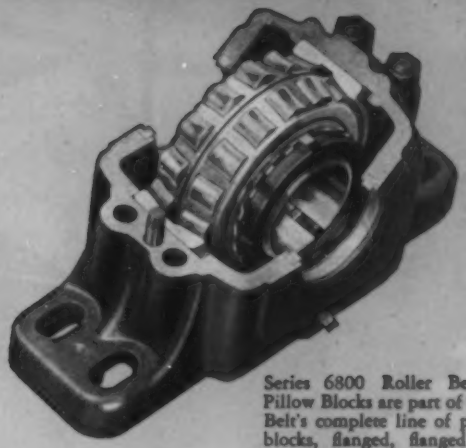
TOUGH JOB?

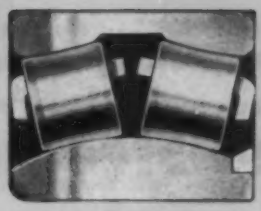


Two Link-Belt Series 6800 roller bearings provide free rolling for huge asphalt drum drives. For chain drives, elevator chain, buckets and other related equipment, F. D. Cummer has long relied on Link-Belt as their sole supply source.

READY ANSWER:



Series 6800 Roller Bearing Pillow Blocks are part of Link-Belt's complete line of pillow blocks, flanged, flanged cartridge, cartridge, take-up and hanger blocks and unmounted bearings.



INTEGRAL SELF-ALIGNMENT Concave rollers operate between convex raceways. Inner ring is true spherical element, free to align in any direction without altering contact with rollers. Symmetrical rollers completely pocketed in retainers for accurate spacing and guiding.

GREATER STRENGTH, LESS WEIGHT AND BULK. Block base is cored to provide uniform metal thickness, assuring a sound casting, free from distortion.

LINK-BELT bearings used exclusively for almost 20 years by F. D. Cummer & Son Co.

BEARINGS that can withstand the shock loads, high temperatures and abrasive grit common in an asphalt plant are indeed proof of sound engineering and top quality. So efficiently have Link-Belt bearings performed in this type of service that F. D. Cummer & Son Co., Cleveland, manufacturers of fine asphalt plants, has used them exclusively for all their shaft support requirements for nearly 20 years.

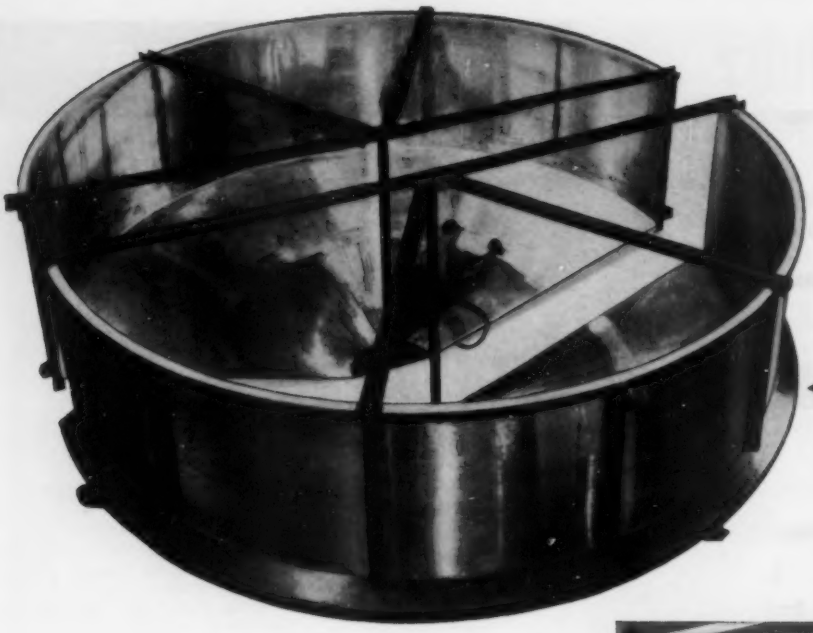
Heavy-duty Series 6800 roller bearings exemplify the design advancements that make precision-built Link-Belt ball and roller bearings first choice for America's hardest working equipment. From their ample reservoirs which prolong lubrication intervals to the compact, self-contained design—every detail contributes to long life and dependable performance. They are completely housing-sealed. Inherent self-alignment assures full load capacity even under shaft deflection or misalignment.

Talk over your bearing problems with a Link-Belt engineer. There is a size and type of Link-Belt bearing that is right for your requirements . . . and they can be supplied from factory branch stores and authorized stock carrying distributors. You can also get complete information by writing for 120-page Data Book 2550.

LINK-BELT

BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.8950



75 Tons of Type 304 Stainless Steel were fabricated for the new Anheuser-Busch West Coast brewhall. Note size of this starting tank, by comparison with workman polishing it at plant of Nooter Corp., St. Louis, Mo.

New Method of Supporting Brewing Tanks, devised by Nooter engineers, provides superior stability and performance. Eliminating usual costly complicated under framing. Nooter suspended three from floor beams of the plant itself, and rested others on steel legs sunk deep into concrete beams in the floor.

All Stainless Steel

Brewhall of Anheuser-Busch Cuts Maintenance and Promotes Product Purity

The new Anheuser-Busch brewery in California's San Fernando Valley is a man-made beauty . . .

It's the nation's first brewhall built to an integrated design, with all equipment of lustrous chromium-nickel stainless steel.

Easy to clean and keep clean, it helps assure product purity in all divisions of the food and beverage industries. That is why Anheuser-Busch selected chromium-nickel stainless with its invaluable protection against corrosion, year-after-year. The smooth, silvery-white surface of the Type 304 stainless steel allows no harbor for contaminants, no chance for product impurity.

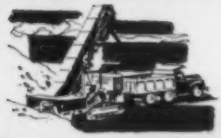
For other industries with different demands, it provides unusual strength at elevated temperatures, yet, in sub-zero service it possesses enviable toughness. It resists wear and has other useful properties. And, of course, it readily responds to all usual forms of fabrication, including welding.

Use chromium-nickel stainless to *improve your products.* Leading steel companies produce these austenitic alloys in all commercial forms. A list of sources of supply will be furnished on request.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

in your DRIVE for lower costs

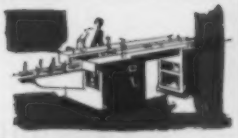


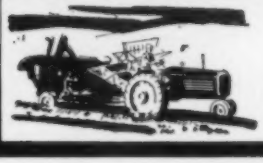
for construction machinery

Chabelco® Steel Chain

Roller Chain

for packaging machinery





for farm implements

Pressed Steel Detachable Chain

Leaf Chains

for lift trucks

for flexible couplings

SHAFER

for self-aligning bearings

And for any drive application, Chain Belt has a size and type of chain and sprocket that can help you in your drive for lower costs. Your Chain Belt District Sales Engineer will be happy to assist you in your drive and conveyor chain, sprocket, flexible coupling, and self-aligning roller bearing selections to get lower costs, improved performance and longer life. Call him or mail the coupon below today.

Always the one best chain for each service

CHAIN BELT COMPANY

District Sales Offices in all Principal Cities

CHAIN BELT COMPANY 54-504
4715 W. Greenfield Ave.,
Milwaukee 1, Wisconsin

I want data on chains for a.....

☐ Send literature on: ☐ Chabelco Chains; ☐ Roller Chains; ☐ Detachable Chains; ☐ Double Pitch Chains; ☐ Leaf Chains; ☐ Flexible Couplings; ☐ Bearings; ☐ Sprockets.
☐ Have a Chain Belt Man call.

Name.....

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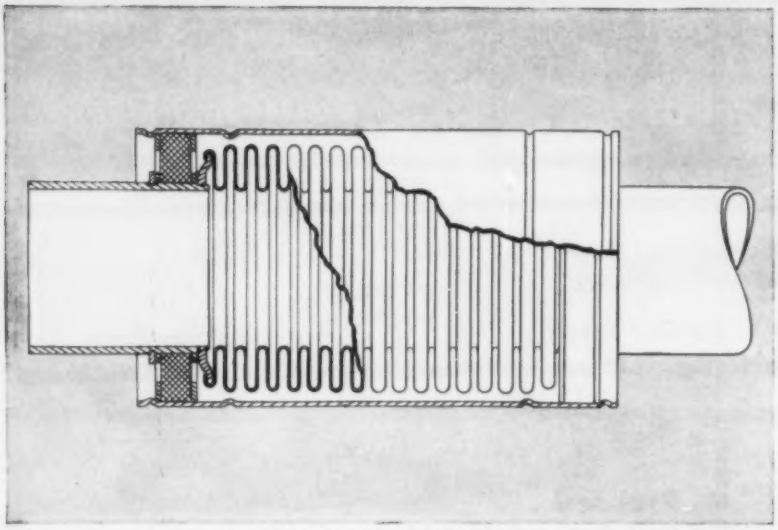
City.....*Zone*.....*State*.....

(*Advertisement*)

How To Provide For Thermal Expansion With Bellows Devices



Expansion joint employs flexible, leakproof bellows to compensate for rapid thermal changes accompanying heating cycle in baseboard radiation systems. Bellows is free to move within protective shield, absorbing pipe expansion. Device eliminates source of common complaints arising from noise produced by expanding pipes grating against floor and wall timbers.

One of the simplest ways of providing for thermal expansion and contraction in fluid systems is through bellows devices incorporated in the original design.

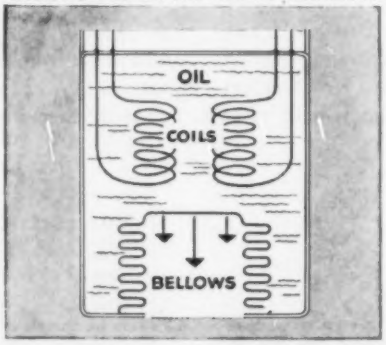
Where heating and cooling of fluids would ordinarily add unwanted stresses or even result in buckling or failure of members, the presence of a leak proof, flexible bellows properly located in the system compensates for dimensional changes. In addition, bellows flexibility permits a certain degree of misalignment to be tolerated without difficulty.

This latter factor can sometimes represent important savings in production since the need for time consuming, precise, "lining up" of elements is eliminated.

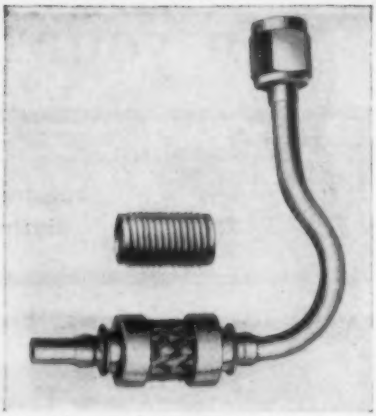
New Expansion Joint employing bellows as the flexible element solved a serious problem for manufacturers of baseboard radiation systems. Developed by the Clifford Manufacturing Company, the bellows joint takes up the expansion and contraction of the pipes with the heating cycle and eliminates the objectionable noises that result from pipes grating against floor and wall timbers.

Flexible Jet Manifold Assembly utilizing a stainless steel bellows as the flexible element solves a high temperature problem for jet engine manufacturers. Two benefits result: dimensional changes are compensated and easy, leakproof assembly of flare fittings can be made without concern for a small degree of misalignment. The protective metal braid and high strength stainless steel bellows make a mechanically rugged joint. Pressure rating is 1000 psi.

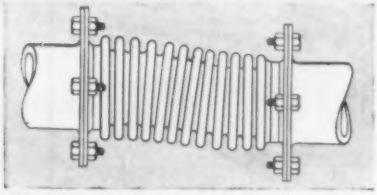
Hermetically Sealed Aircraft Transformers employ a built-in bellows within the sealed chamber



to compensate for expansion and contraction of the oil fill with temperature changes. The bellows thus prevents the development of high pressures within the unit and at the same time maintains a leakproof hermetic seal.



Flexible manifold assembly is designed around a stainless steel bellows for high temperature and anti-corrosion service. Flexibility of bellows simplifies alignment, permits easy, leakproof assembly of flare fittings and allows for thermal changes.



Flexible Piping and flexible connectors are other applications where bellows allow for thermal expansion and mechanical displacement. In high temperature piping systems for example, bellows connectors absorb expansion and contraction and permit lateral motion of pipe supports with respect to one another. In aircraft applications, flexible bellows connectors are employed in hot air de-icing systems where flexing of the wings requires equivalent flexing of the ducts.

Your Design Problem involving thermal compensation or mechanical misalignment may be solved with a bellows device. Clifford will be glad to offer engineering help. Simply sketch the controlling dimensions and specify the service conditions. We will help you arrive at a proper design and produce in quantity to your specifications.

Write: Clifford Manufacturing Company, 122 Grove Street, Waltham 54, Massachusetts. *Division of Standard-Thomson Corporation.* Sales offices in New York, Detroit, Chicago, Los Angeles and Waltham, Mass. 7.4.23

Bellows And Bellows Devices

CLIFFORD
MANUFACTURING CO.
WALTHAM, MASS.
DIVISION OF STANDARD-THOMSON CORP.

Aircraft Heat Exchangers Valves Electronic Equipment

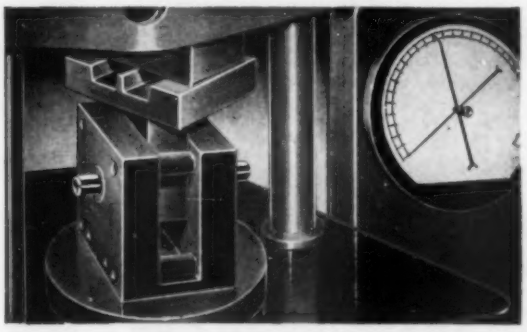
Normal leverage puts the load on the pins at these points. Pins must have a high resistance to shearing — and every pin must stand up to plenty of abuse. Many manufacturers' tests have proved Rollpin's uniformly high shear strength.

consistent strength... as important in the pin as in the socket

The Moore Drop Forging Company, who manufactures the famous Craftsman wrenches for Sears Roebuck and Co., used stainless steel rivets to fasten the universal joint on their Flex sockets. Thorough testing, under all possible load conditions and drive angles, convinced them that Rollpin was stronger than the stainless steel rivet previously used. This led to a redesign of the joint with Rollpins replacing the rivets. Also, the spring tension inherent in the Rollpin locking principle was used to provide the "drag" that holds the socket head in angular position. The result . . . an improved product at lower cost.

Dependability like this is based on the rigid ESNA® quality controls that insure consistent strength and mean reliable performance by every Rollpin.

Moore Drop Forging Company was able to save assembly time, too. Rollpin is simply driven into holes drilled to normal production tolerances. It compresses as driven, locking itself in place by exerting pressure on the hole walls. In this case, the extra operation of spinning on a rivet head was eliminated.



We urge you to test spring pins before you buy — for uniformity of diameter and length, hardness, insertion and removal forces, and recovery of diameter, as well as shear strength.

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. R29-102, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

- ☐ Rollpin samples
- ☐ Rollpin bulletin
- ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

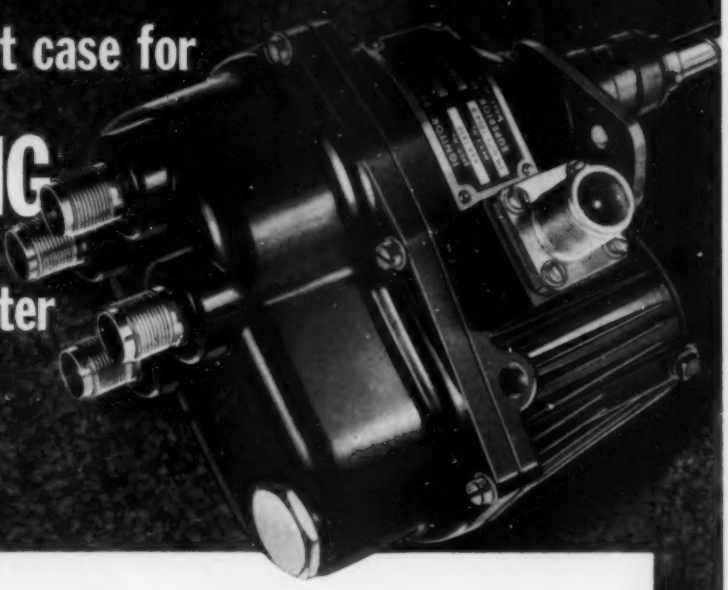
Name_____ Title_____

Firm_____

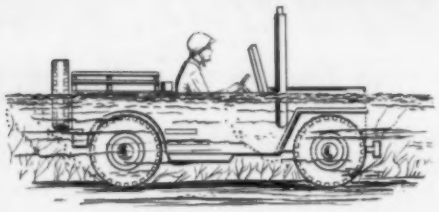
Street_____

City_____ Zone_____ State_____

Here's a watertight case for DIE CASTING ...in this underwater ignition housing



CASE HISTORIES FROM MT. VERNON FILES

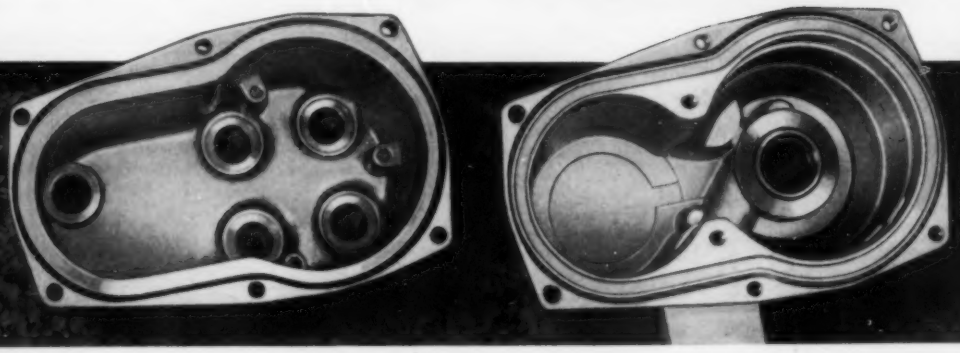


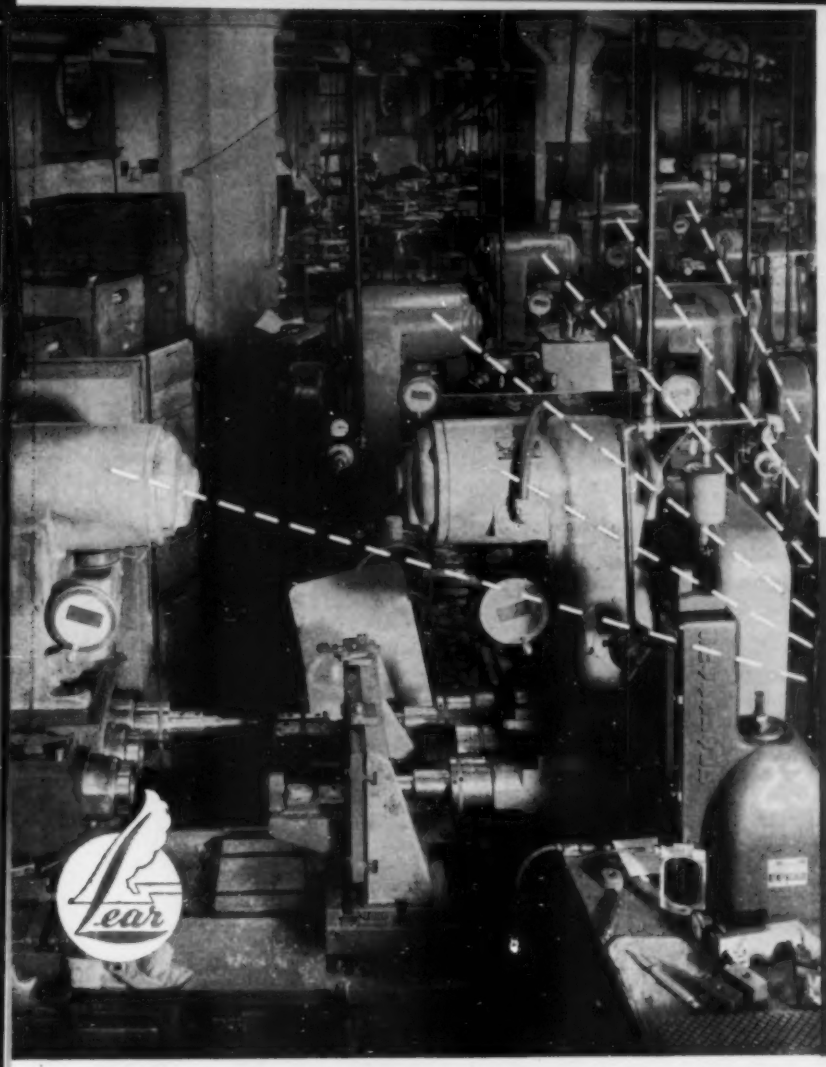
This is a waterproof "Ignitor"—a distributor and ignition coil combined in one case—for a motor vehicle which must operate at times under water. Searching for the *best* way to produce the intricate housing which must keep its contents bone-dry under pressure, the makers, Superior Magneto Corp., Long Island City, N. Y., chose a 2-piece case die cast in aluminum by Mt. Vernon.

Says Superior Magneto: "With die casting we get light weight, with thin walls of great strength and uniform density, able to stand a 300-hour 2½ G. vibration test. With a minimum of machining, dimensional stability is so good the parts are interchangeable, with no need for hand fitting. Both the brass bushings for spark-plug wires and the steel drive-shaft bushing are integrally cast—and they're tight enough to keep out water under pressure. Finally, the finish of the castings is so good, we apply the protective coating directly, without sand blasting or cleaning. All these add up to a fine product, economically made."

Whatever your product, whether simple or intricate, consult with us. We have 162,000 sq. ft. of facilities for die casting aluminum and zinc, and a vast reservoir of experience in die making. Perhaps we can help you, as we helped Superior Magneto, to lower unit costs . . . show you the way to improved products, too.

MT. VERNON DIE CASTING CORP.
STAMFORD, CONNECTICUT





LEAR, INC., ELIMINATED FINISH GRINDING OPERATION WITH SPEED-TROL

Speed-Trols on boring machines at Lear, Inc., Grand Rapids, Mich., resulted in elimination of a grinding operation and a reduction in manufacturing costs. This was accomplished through Speed-Trol's infinite speed adjustment and accurate speed regulation which allowed selection of the best cutting speeds for Carboloy or diamond tipped boring tools and boring to extremely close tolerances which obviated the need for a former final grinding operation.

Industry Names Speed-Trol Production Advantages

In a nation-wide user survey of Sterling Speed-Trol Variable Speed Electric Power Drives:

86% Increased Production. **48%** Improved Product Quality. **64%** Reduced Production Costs. **42%** Modernized Equipment and Machines. **20%** Reduced Spoilage and Rejects. **28%** Increased Machine Versatility. **18%** Increased Plant Safety. **34%** Improved Employee Morale. **62%** Lowered Maintenance Costs. **46%** Saved Space. **18%** Simplified Operations. **16%** Synchronized Operations.

Investigate the possibilities of bringing some of these Speed-Trol production advantages to your plant. Sterling Engineering Sales Offices and over 400 Distributors and Service Shops throughout the nation effectively serve every industrial, commercial and agricultural area.

20-PAGE ILLUSTRATED CATALOG ... Sterling Speed-Trol, Slo-Speed, Klosd and Klosd-Tite Electric Power Drives. Write for catalog No. K-131

There is a Sterling Electric Power Drive to Meet Virtually Every Requirement

Sterling Slo-Speed Electric Power Drives—for geared low speed at its best
Sterling Klosd and Klosd-Tite Motors—for constant normal speed at its best

STERLING ELECTRIC MOTORS

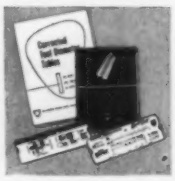
Plants: New York City 51 • Chicago 33 • Los Angeles 22 • Hamilton, Canada • Santiago, Chile
Offices and distributors in all principal cities

Look what you can do with Alcoa® Aluminum on your six-spindle Conomatics

Conomatics are the only multiple bar automatics built with short, "weaveproof" upright frame members secured between a large, heavy top bed and base. Such construction makes possible a strong bridged support for the tooling area and its "work and tool axis."

With such a strong and sturdy frame, you can really "horse" Alcoa Aluminum Bar Stock through your Conomatics. Finished parts are smooth, with dimensional tolerances held to consistently close limits. Piece costs are lower, since from a pound of aluminum you can get three times as many parts as from a pound of the heavier metals. What's more, aluminum parts won't rust or corrode and are exceptionally good conductors of electricity and heat.

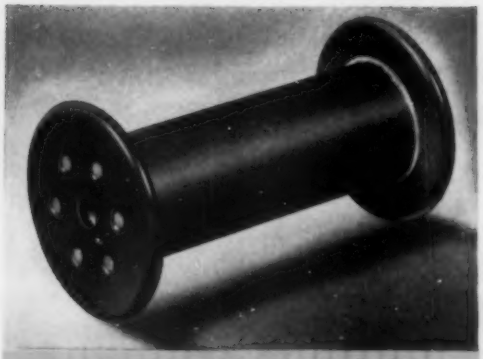
Find out more about Alcoa Aluminum Screw Machine Stock—today. Contact your local Alcoa sales engineer or Alcoa distributor. Both are listed under "Aluminum" in the classified section of your telephone directory. Or write, ALUMINUM COMPANY OF AMERICA, 853-K Alcoa Building, Pittsburgh 19, Penna.



PRODUCTION AND DESIGN ENGINEERS will want two Alcoa booklets, *Alcoa Aluminum in Automatic Screw Machines* and *Corrected Tool Diameter Tables*. Also available at no extra cost are two precision computers—a Speed-Feed calculator, and an alloy property guide which shows at a glance the various properties of Alcoa Aluminum Screw Machine Stock.

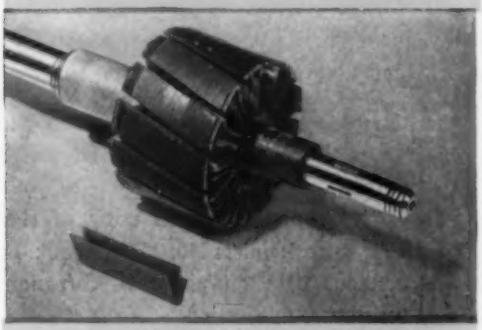
ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA



Smooth finish retention makes Taylor Bobbin Fibre ideal for textile bobbins. High impact strength and easy machining add to its value.

Flexibility gives long life to abrasive discs backed with Taylor Vulcanized Fibre, which retains strength under repeated bendings.



Toughness of Taylor Vulcanized Fibre slot wedges protects motor windings . . . gives dependable electrical insulation.

●

Also available from Taylor—

. . a varied line of high-quality laminated plastics, including phenol, melamine, silicone, epoxy and combination laminates . . . and polyester glass rods.

. . complete fabrication service, on an economical, prompt-delivery basis, for your vulcanized fibre or laminated plastic parts.

Your new designs can profit with Taylor Vulcanized Fibre

When you're looking for a material to fill a tough assignment . . . in your new designs or in present products . . . don't overlook the many unique qualities of Taylor Vulcanized Fibre. It offers a combination of physical characteristics, electrical properties and economic advantages that you may find add up to the best answer for your product.

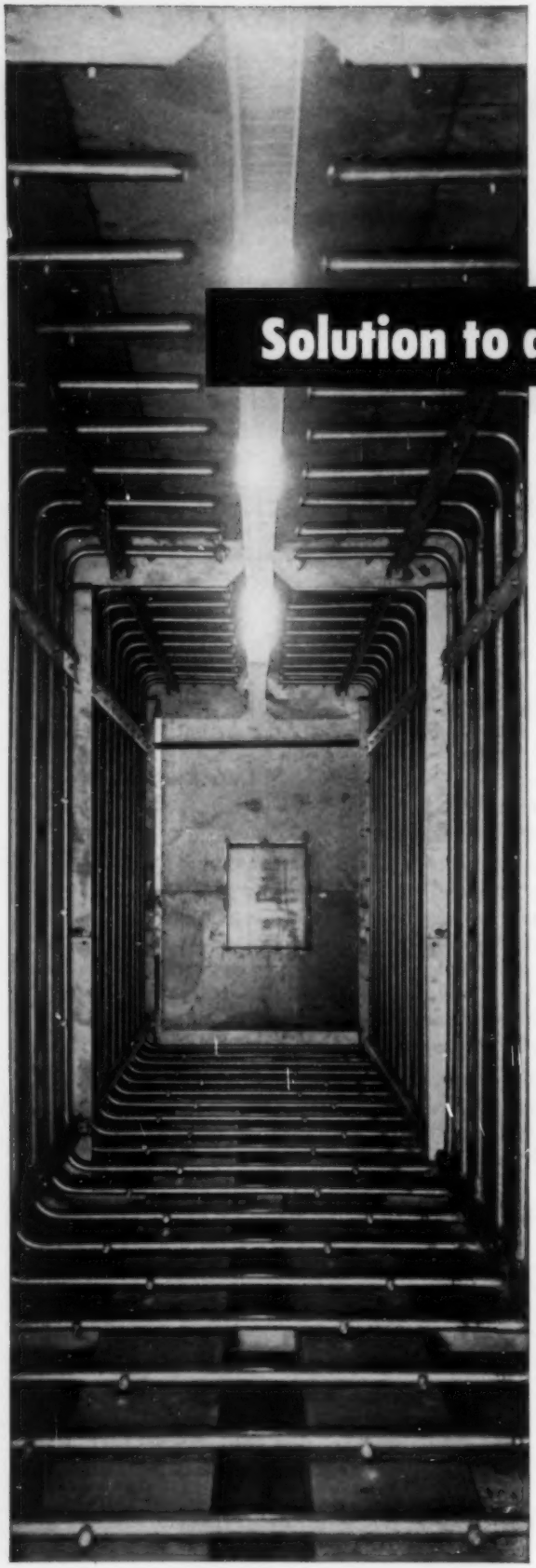
It's tough, flexible and strong. It withstands impact, resists wear and abrasion . . . and is a good electrical insulator. And it's exceptionally economical to machine . . . cuts, drills and bends readily. It comes in sheets paper-thin to several inches thick . . . rolls . . . strips . . . rods . . . and in a variety of colors. A wide selection of grades probably includes a type that exactly meets the requirements of your particular application.

Taylor specialists will be glad to help you apply Taylor Vulcanized Fibre in your production. Or, you may find it pays to have Taylor's Fabricating Division furnish the completed part to your specifications.

TAYLOR FIBRE CO. Plants in Norristown, Pa., and La Verne, Calif.

Branch offices *in Atlanta; Boston; Chicago; Cleveland; Dayton; Detroit; Indianapolis; Los Angeles; Milwaukee; New York City; Philadelphia; Rochester; San Francisco; St. Louis; and Tolland, Connecticut. Distributors in Grand Prairie and Houston, Texas; Jacksonville, Florida; New Orleans, Louisiana; and Toronto, Ontario.*

TAYLOR
Laminated Plastics
Vulcanized Fibre



Solution to a Hot Solution Problem

Carpenter Stainless No. 20 Handles Hot Sulphuric Acid—Solves Corrosion Problem

In this spray booth metal parts are cleaned by a solution of hot sulphuric acid. Booth is fabricated from Carpenter Stainless No. 20 Cb pipe, tubing, sheet and plate.

When you have sulphuric acid or other strong corrosives to handle—or are fabricating equipment to do the job—remember Carpenter Stainless No. 20—also available in bar, wire and strip.

Highly resistant to concentrations or solutions of H_2SO_4, and unaffected by a long list of other highly corrosive acids, liquids, gases, Carpenter Stainless No. 20 cuts the cost of corrosion control. What's more, it has the ductility and general workability for trouble-free bending, machining, threading, welding and brazing.

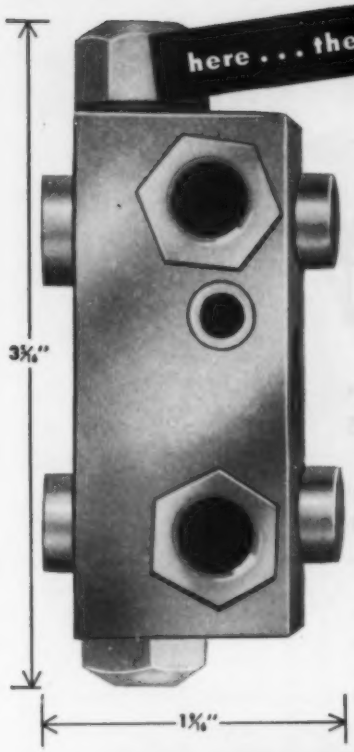
Now is the time to get complete information on Carpenter Stainless No. 20 Cb in its many forms—see what it has to offer you. Write today for your copy of the Carpenter Stainless No. 20 handbook. It contains data on physicals, corrosion resistance, fabrication.

The Carpenter Steel Company, Alloy Tube Division, Union, N.J.
Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

here . . . the "lubrication fitting" that never forgets!



ALEMITE Accumeter®

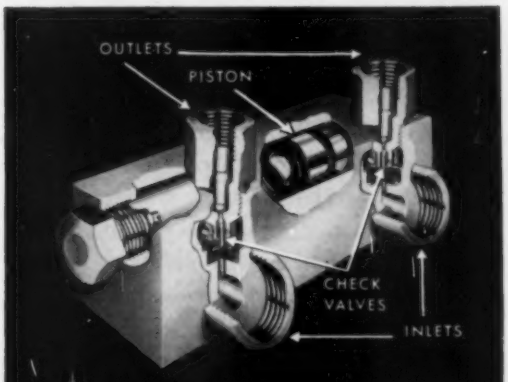
provides automatic, fool-proof lubrication for the heaviest, biggest machines, operating under the toughest conditions . . . indoors or outdoors!

Picture a machine under the toughest job conditions you can imagine. Where bearings operate under the *worst* conditions—in dust, rain, fumes, grit—even completely immersed. Here, ordinary manual lubrication methods would be costly—man-hours would be wasted and production time lost while the machine was shut down for lubrication.

If you were designing this machine, what method could you specify to make sure *every* bearing would always be properly lubricated?

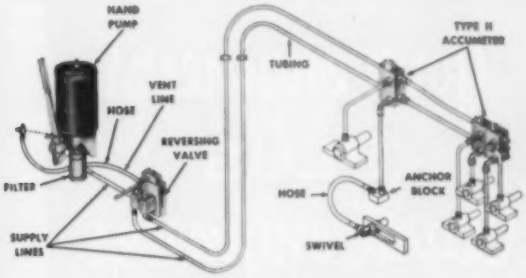
Here's the answer—Alemite Accumeter, the valve that is far more dependable than any man. This simple, completely sealed system delivers an *exact* amount of lubricant where it is needed at *exactly* the right time—*while the machine is in operation!* Time, maintenance and production costs drop—while output soars! No wonder more than 95% of all major plants buying machine tools specify centralized lubrication!

And Alemite Accumeter Systems are easy to design into any machine—and there is a system ready to solve any machine lubrication problem. Find out about these automatic systems now. See for yourself the tremendous savings and efficiency they allow you to offer when you specify automatic Accumeter.



Type II Accumeter Valves

Each serves two bearings. In four sizes delivering from .010 to .500 cubic inch of lubricant. Adjustable. Fully hydraulic—no springs. Completely sealed system serves up to 600 bearings. Manual or power operation.



offers all these advantages!

- Eliminates shut-down time for lubrication. Adds productive time to machine output.
- Seals completely against dirt, grit, fumes, water all the way from "barrel to bearing."
- Prevents bearing troubles due to neglect or wrong lubricant.
- Services all bearings—including those inaccessible or dangerous—in one operation.
- Avoids work spoilage and bearing repairs due to over-lubrication.

factory tested—field proved

Exhaustive, in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles. Equal to 122 years of twice-a-day service!

Free—*Alemite Accumeter Catalogue*

ALEMITE, Dept. T-104
1850 Diversey Parkway, Chicago 14, Illinois

Name.....

Company.....

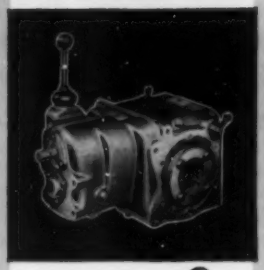
Address.....

City..... State.....

ALEMITE

REG. U. S. PAT. OFF.

A PRODUCT OF SW STEWART-WARNER

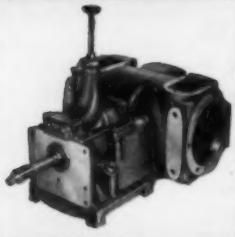


your engineers PLUS Clark engineers

Your engineers may have a dynamic idea for increasing operating efficiency of a certain piece of equipment. Their major problem is to be *certain* that the axle-transmission drive units will withstand this newly-visioned power and operational efficiency.

That's when *Clark* engineers can step into *your* picture. For more than a quarter of a century they have been solving similar problems. Working with *your* engineers they can contribute ingenuity combined with practical approach that *will* result in a dependable, rugged driving unit that fits your needs.

IT'S ALWAYS GOOD BUSINESS TO DO BUSINESS WITH CLARK.



CLARK EQUIPMENT

* TRADEMARK OF THE CLARK EQUIPMENT COMPANY

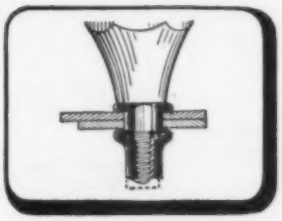
CLARK EQUIPMENT COMPANY
BUCHANAN, MICHIGAN
Other Plants: Battle Creek • Jackson
and Benton Harbor, Michigan

One B. F. Goodrich Rivnut does two fastening jobs, cuts assembly cost!

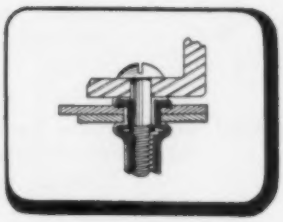
Rivnuts provide at least 6 clean threads in one simple operation!

1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.

2. Rivnut is inserted—head firmly against work—tool at right angles to work.

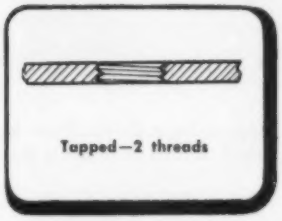


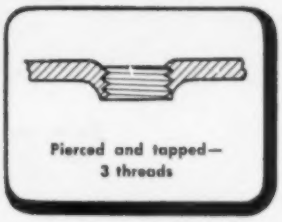
3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

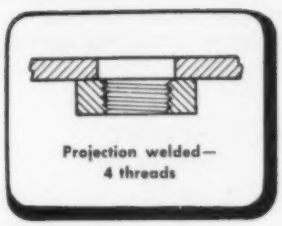


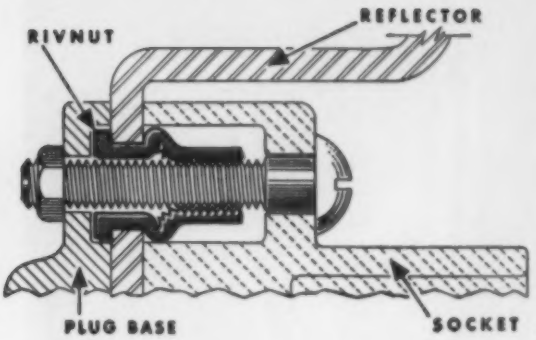
4. After upset, Rivnut threads are still clean and intact, ready for screw attachment.

Compare these 4 methods of putting screw threads in thin sheet metal









B. F. GOODRICH RIVNUTS cut assembly time and costs since they provide a firm, accurate nut plate in one quick operation. Welding, tapping are eliminated. Rivnuts can be installed from *one side* and can take an attachment bolt from either end.

In the application above (assembling spotlights) Rivnuts completely eliminated use of threaded studs which required welding in close quarters. They also eliminated a separate piercing and tapping operation and made it possible to attach nuts from the outside of the assembly instead of the inside. Rivnuts provided further cost savings since they could be attached *after* enameling without marring the finish of the unit.

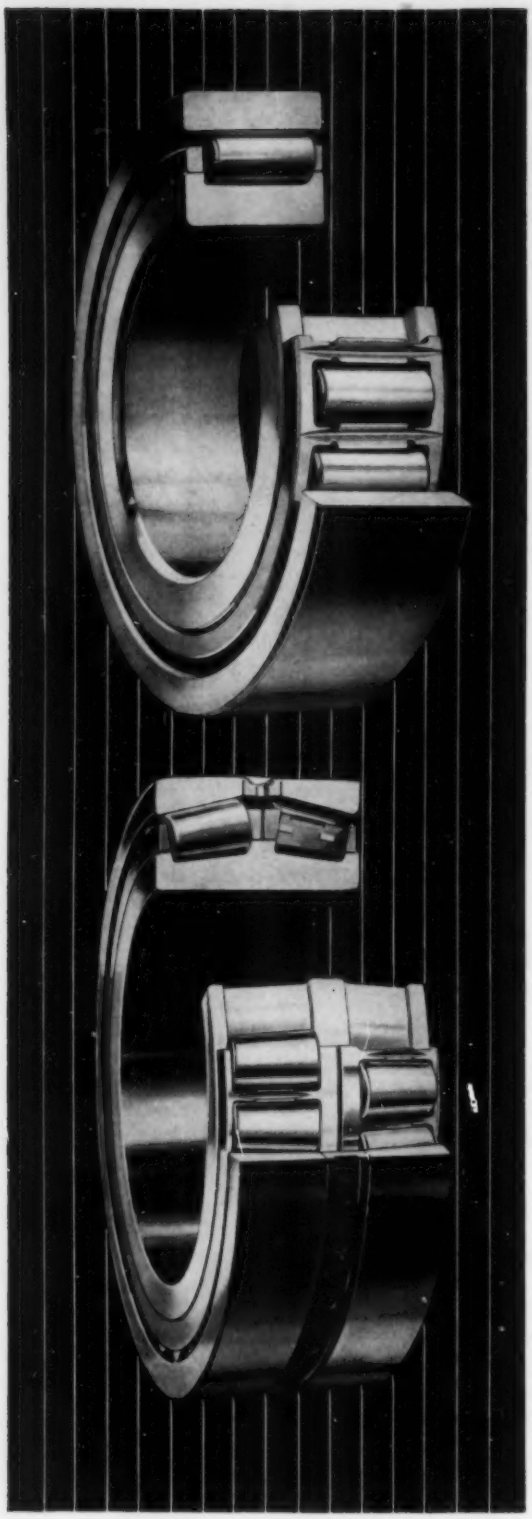
Whatever your fastening problem, there's probably a B. F. Goodrich Rivnut that can cut both assembly time and costs. Get complete information and engineering help by calling in a B. F. Goodrich Rivnut engineer. *The B. F. Goodrich Company, Department PE-10-4, Akron, Ohio.*

SEND NOW . FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department PE-104, Akron, Ohio.

B.F.Goodrich RIVNUT

The only one-piece blind rivet with threads

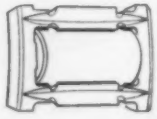


Here's how TORRINGTON Cylindrical and Tapered Roller Bearings ...Cut your costs, increase efficiency

Finest bearing-quality steels purchased to our specifications, plus modern heat-treating methods, insure highest load-carrying capacity, long life, and resistance to wear.

Precision tolerances and finishes on both rollers and races assure low eccentricity and uniform load distribution, cut friction to a minimum.

Individual roller retainment keeps rollers well lubricated, simplifies inspection of race surfaces.



Stabilized races maintain accuracy of fit under severest operating conditions.

One-piece cast-bronze cages help minimize wear, lengthen bearing life.

Rollers accurately guided at the pitchline—by contacting machined pads on each pocket face.

Custom engineered to meet your load and speed requirements, TORRINGTON Cylindrical and Tapered Roller Bearings increase operating efficiency in the toughest heavy-duty applications. Interchangeable in all types and sizes.
SPECIFY TORRINGTON!

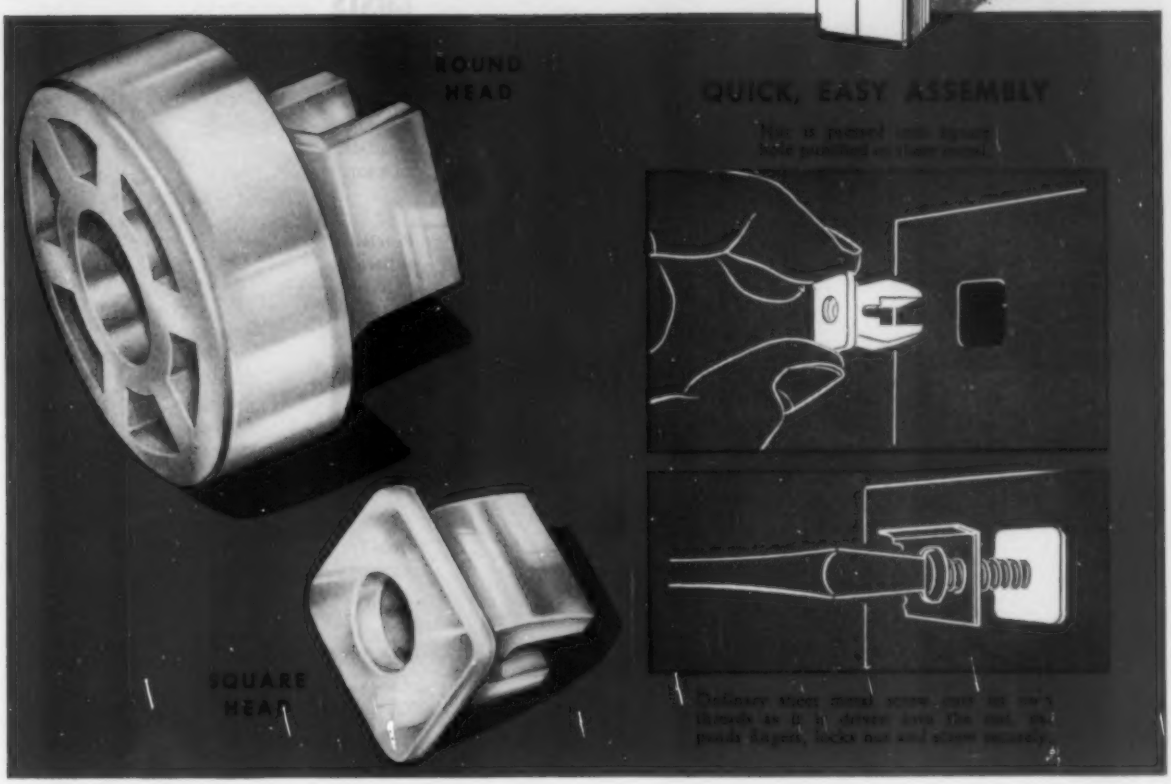
THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

How many ways can **you** use

DOT PLASTIC *snap in* NUTS?



United-Carr's new self-locking, plastic nut is designed for blind application and can be used with all types of metal finishes without scratching or chipping the surface. Its plastic fingers provide rigid anchorage yet will not mar paint, polished metals or even porcelain.

Inexpensive sheet metal screws cut their own threads and expand the nut's fingers as they are driven, locking both nut and screw tightly in place. Screws can be removed and replaced several times without damage to the nut.

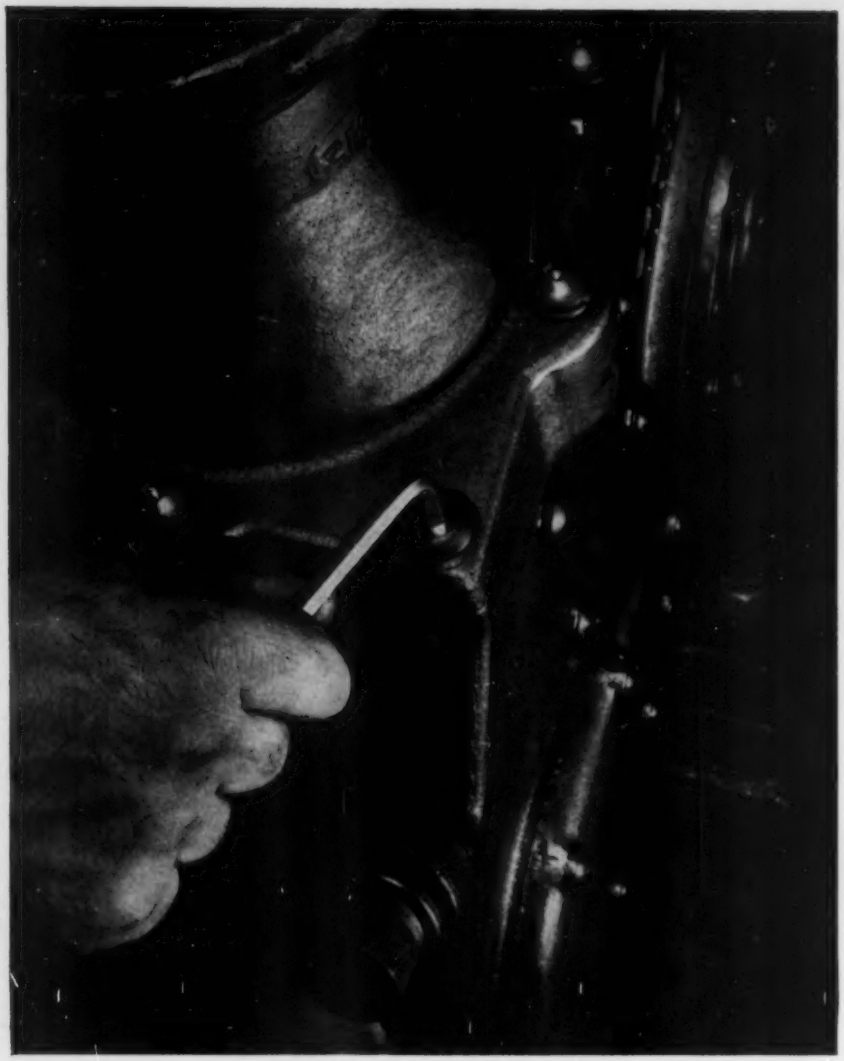
DOT plastic snap-in nuts are electrically non-conductive and provide a high degree of insulation against heat transfer. For all practical purposes, they also provide an effective vapor seal.

Available in several styles and sizes. Write for full information and samples or contact your nearest United-Carr representative.

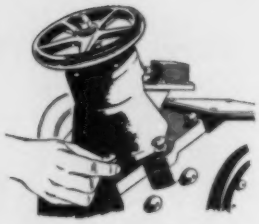
UNITED-CARR FASTENER CORP.

CAMBRIDGE 42, MASSACHUSETTS

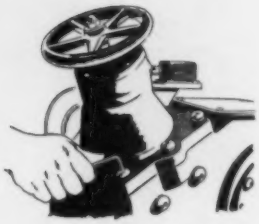
MAKERS OF DOT *FASTENERS*



UNBRAKO button head socket screws are used exclusively to assemble this controlled volume pump, which was designed to fill the growing industrial need for the pumping of an allotted quantity of liquid at higher pressures, higher capacities.



The assembler inserts the UNBRAKO button head socket screw with his fingers, and runs it down as far as he can.



He then tightens it with a standard UNBRAKO key. Once seated, the low head design of the UNBRAKO button head provides a smooth, streamlined appearance.

UNBRAKO Button Head Socket Screws are made of heat treated alloy steel; have fully formed threads, Class 3 fit; are available in standard sizes from #8 to ⅜". Accurate hex socket provides nonslip drive, prevents marring or mutilation of the head.

Save inventory dollars

Use UNBRAKO Standards—stocked by your distributor

Not only does your UNBRAKO distributor lower inventory investment, he also saves you time—and provides latest information about products, cost-saving methods, production techniques, current problems, trade practices. For latest data on UNBRAKO standard socket screw products, consult him or write STANDARD PRESSED STEEL COMPANY, Jenkintown 28, Pennsylvania.

UNBRAKO® SOCKET SCREW DIVISION

SPS JENKINTOWN PENNSYLVANIA

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Yours for Just One Dollar!

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Take advantage of this unusual offer to prove to yourself the superior benefits offered by Bruning's new, improved Tracing Papers. Look for the following specific benefits—they are the results of new advances in manufacturing techniques and the use of specially improved ingredients.

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Enclosed find $1.00. Please send me 5-yard, 36-inch roll of your new, improved tracing paper at no further cost to me.

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With the new addition, the University of Washington's stadium holds some 55,000 people. Mayari R was used for the seat brackets primarily for high tensile strength and corrosion-resistance.

Steel for 7,000 seat brackets had to be formable, weldable, corrosion-resistant

Everybody loves a football game, it seems, and so the University of Washington decided to enlarge its stadium by 15,000 seats. To support the new seats, 7,000 steel brackets were needed. They had to be strong, of course, and able to endure constant exposure to the atmosphere. They were to be formed from channels to the shape shown at right, and then welded into position.

These requirements led Century Metal Works, Seattle, who fabricated the brackets, to select Mayari R high-strength, low-alloy steel. Because it has 5 to 6 times the atmospheric corrosion-resistance of plain carbon steel, and nearly 50 pct greater tensile strength, designers knew that Mayari R would provide safe, long-lasting seat supports.

Century Metal Works found that they could cold-form Mayari R in practically the same way as plain carbon steel, without any special equipment. Welding the brackets in place posed no problems, either, since Mayari R welds as readily as any steel, and more readily than some.

These seat brackets illustrate how manufacturers and fabricators can take full advantage of Mayari R's superior qualities without having to adopt special shop techniques or equipment. The cold-forming, hot-forming, shearing, flame-cutting, punching, machining or welding of this versatile steel require little if any variation from normal procedures.

Our new Catalog 353 digs pretty thoroughly into Mayari R's properties and possibilities. You'll find this book worth having. You can get a copy through the Bethlehem office nearest you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

BETHLEHEM STEEL

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

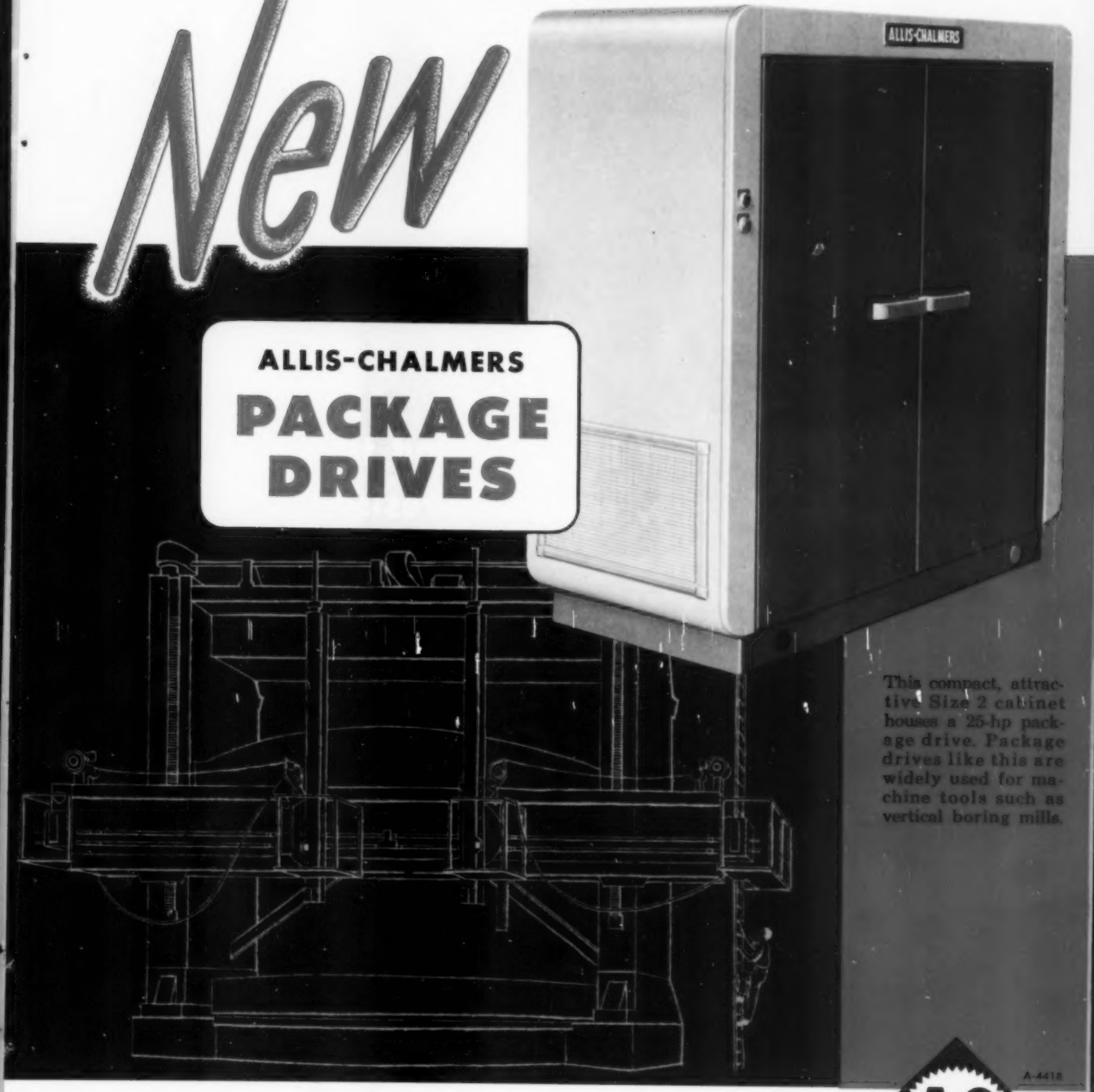
Mayari R *makes it lighter... stronger... longer lasting*

HERE'S ADVANCED-DESIGN SPEED CONTROL

New

ALLIS-CHALMERS

PACKAGE DRIVES

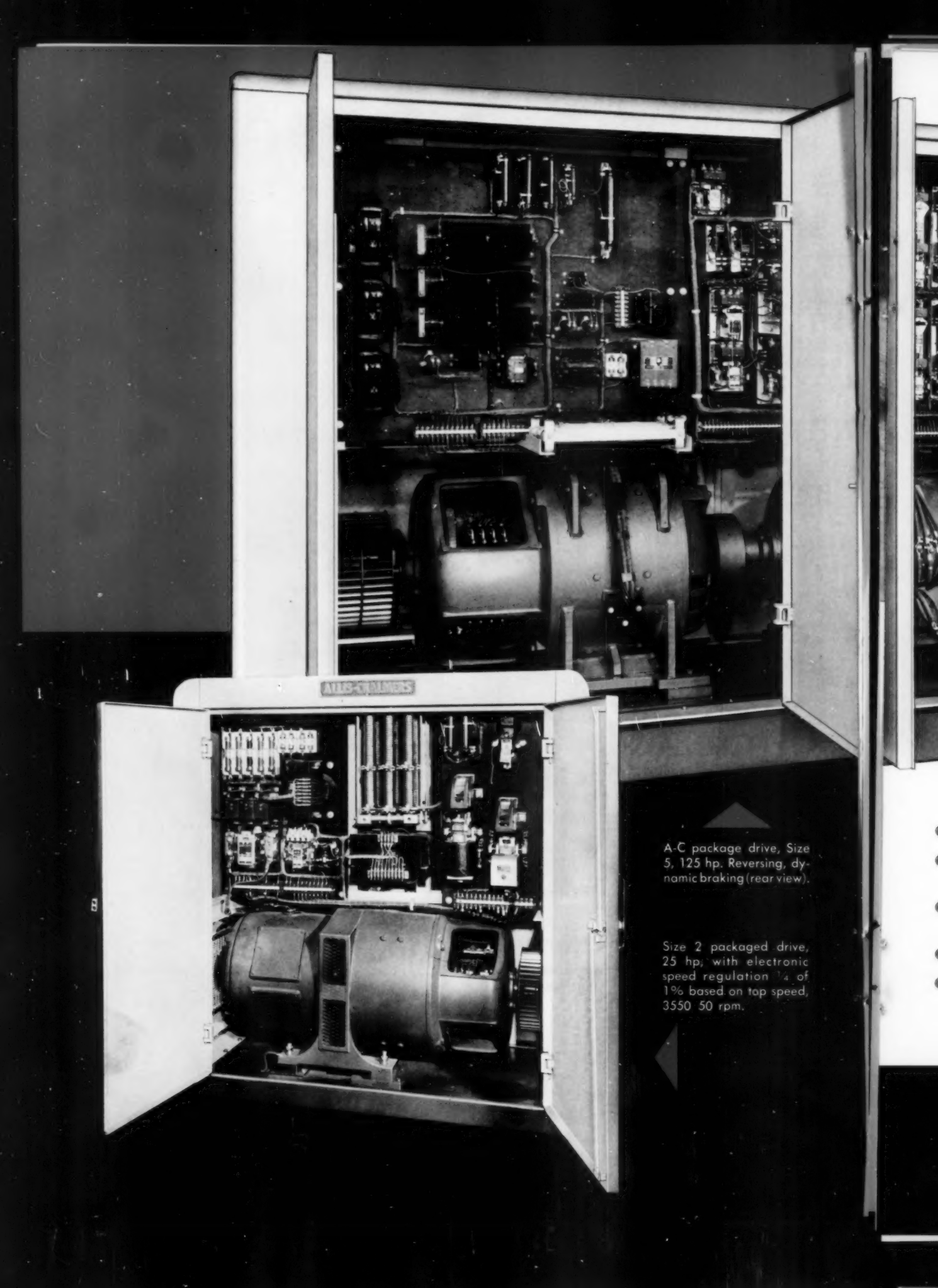


This compact, attractive Size 2 cabinet houses a 25-hp package drive. Package drives like this are widely used for machine tools such as vertical boring mills.

A-4418

ALLIS-CHALMERS

A-C ALLIS-CHALMERS



A-C package drive, Size 5, 125 hp. Reversing, dynamic braking (rear view).

Size 2 packaged drive, 25 hp, with electronic speed regulation ¼ of 1% based on top speed, 3550 50 rpm.

ALLIS-CHALMERS PACKAGE DRIVES

For speed control of machine tools and other applications requiring accurately variable speed over a wide range

Get ALL of these advanced features

- Magnetic amplifier generator field control.
- All machine functions controlled from one or more remote points.
- Potentiometer rheostat in control station (optional).
- Control may be preset for repetitive operations.
- Full protection against overload, undervoltage. Other protective devices to suit the application.
- Complete group of optional features including:
  — dynamic or regenerative braking
  — reversing
  — jogging
  — controlled rate of acceleration and deceleration

GET COMPLETE DETAILS on the Allis-Chalmers Package Drive to fit your particular application. Available in 5 cabinet sizes — 5 to 150 hp. Call your nearby Allis-Chalmers Office or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Package Drive Bulletin 51B8166.

ALLIS-CHALMERS

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Milwaukee 1, Wisconsin

Everything You Need...
from Power Line to Driven Shaft

Motor, Control, *Texrope* V-belt Drive
. . . All from one reliable source

You will save time and engineering costs and reduce assembly problems when you use an Allis-Chalmers complete machine drive. Components are of coordinated design and manufacture. Ratings coincide and parts fit and work together properly when assembled. One requisition, one order, one invoice saves on paperwork. And you can obtain engineering assistance from qualified field application engineers who thoroughly understand the complete drive problem.

NATION-WIDE CERTIFIED SERVICE

Almost a hundred Allis-Chalmers Certified Service Shops in industrial areas in all parts of the country provide factory-approved service and parts. If you use a special motor, Certified Service Shops have the full benefit of factory drawings and advice for service work.

Call the Allis-Chalmers District Office near you next time you have a drive problem. A competent application engineer will be glad to put the full facilities of Allis-Chalmers at your disposal.

Texrope is an Allis-Chalmers trademark

ALLIS-CHALMERS

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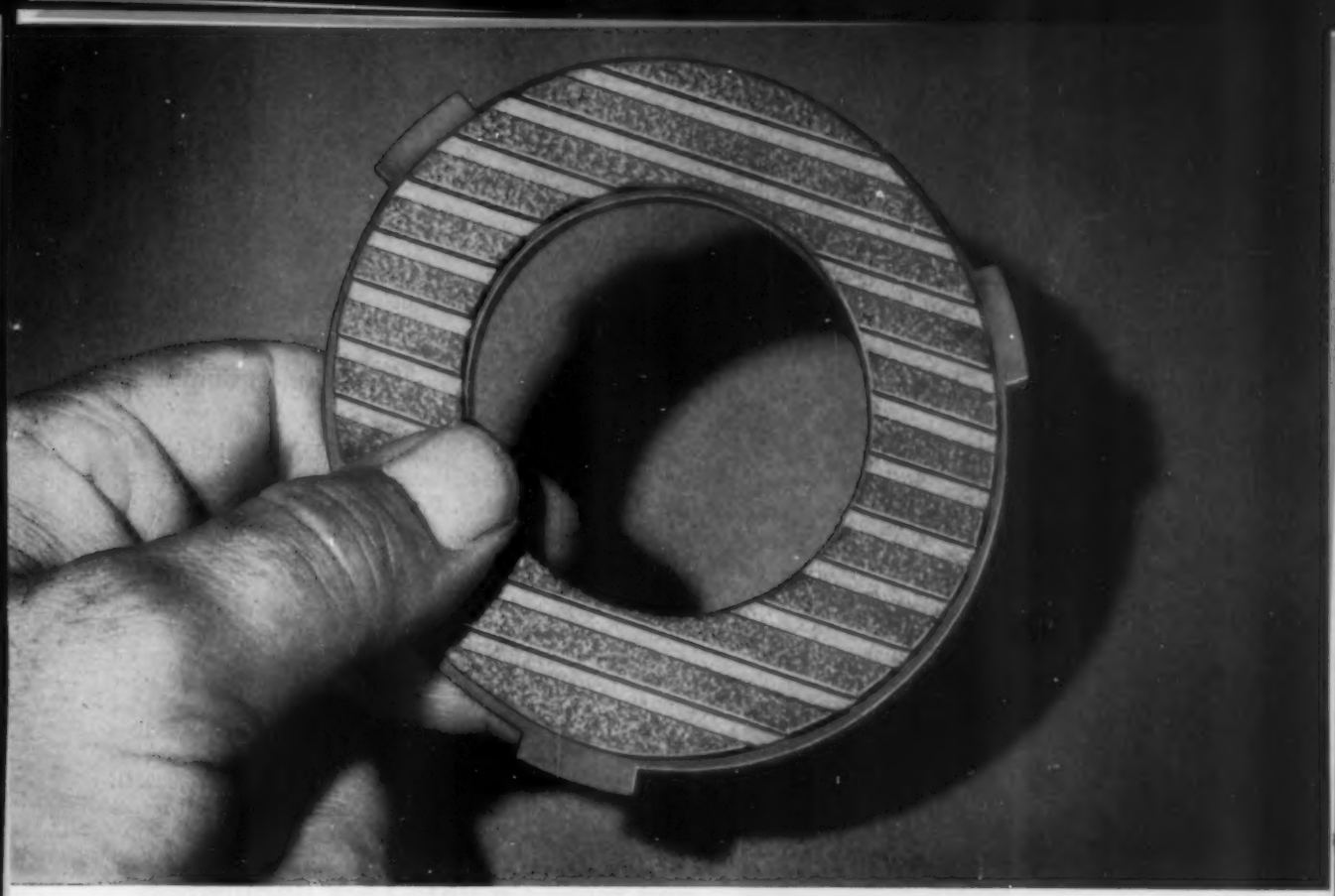
Milwaukee 1, Wisconsin



in **APPLIANCE CLUTCHES . . .**

cork facings give low-cost, trouble-free performance

If you want clutches that deliver dependable performance for the life of an appliance—yet cost less to manufacture and maintain—you should investigate cork clutch facings.

Cork has a high coefficient of friction, even when immersed in oil. Therefore, it's normally possible to use fewer or smaller plates or reduce engagement pressure and still get the desired torque capacity.

In a properly designed wet clutch, cork facings engage smoothly and operate quietly. Wear on facings is very slight, and there are no damaging particles that can be released into the oil. Since cork is resilient, facings conform to opposing plates perfectly.

A good example of cork's advantages is found in the experience of a manufacturer of well-known automatic washers. When he switched from stamped metal plates to cork facings, he solved his major clutch production and service problems. Until he made the change, his clutches required a preliminary break-in period plus a draining and refilling of the oil. Even with this precaution, abrasive particles continued to damage gears and facings, causing clutches to fail. Service and replacement costs were excessive.

When he substituted cork, clutch service calls and replacements were virtually eliminated. And because of cork's high torque capacity, it was actually possible to use only *three* cork-compounded facings in place of the original *eight* metal friction surfaces.

Perhaps cork's high torque capacity and dependable performance can help your clutches work better, too. Tell us your application—appliance, automotive, business machine, or industrial equipment—and we'll gladly help you choose the most efficient cork facings for your clutches. Write Armstrong Cork Company, Industrial Division, 7210 Imperial Avenue, Lancaster, Pennsylvania.

ARMSTRONG'S FRICTION MATERIALS

"Nothing can go wrong with Roto-Lock performance"

Says Elgin Metal Casket Company

Roto-Lock operation is simple: Serrated, tapered cam engages latch — draws panels tightly together when turned by crank or other hand tool.

Simmons Roto-Lock Fasteners are used by Elgin Metal Casket Co., of Elgin, Illinois, to give its Permaseal Caskets a perfect hermetic seal against air and water. Drawn down with a pressure of up to 1500 lbs., Roto-Lock guarantees an absolutely tight seal and strength far beyond requirements.

President E. B. Stewart of Elgin says: "Roto-Lock worked out particularly well because of the simplicity of its construction, and the fact that it was a lock already in a housing which could readily be sealed. Functionally the lock is very good since it pulls the lid down with ease and is a quick-operating mechanism. In other words, *the locking and sealing operation can be accomplished quickly and easily in a matter of seconds.* Since the whole locking and sealing mechanism contains only one moving part, *there is nothing that can go wrong with the performance of the lock.* Of course, this is important since mal-function at a funeral service would be a serious matter."

and there's a Roto-Lock application to improve your product

Roto-Lock, which makes butt or right-angle joints quickly, is finding wide application in portable shelters, air freight and cold storage shipping containers, walk-in coolers, demountable furniture and scaffolding. It fastens in any misaligned or semi-open position and recesses completely into panels. *Wherever* demountability is important, there's a Roto-Lock application.

Write today for our 36-page catalog. It's filled with applications of Roto-Lock and Simmons' four other special fasteners engineered to improve products and reduce assembly costs.

SIMMONS FASTENER CORPORATION
1751 N. Broadway, Albany 1, New York

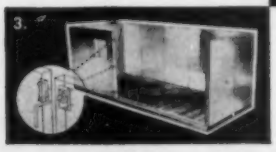
Simmons

QUICK-LOCK · SPRING-LOCK · ROTO-LOCK · LINK-LOCK · DUAL-LOCK

FASTENERS WITH USES UNLIMITED

Some applications of Roto-Lock:

1. Portable Shelter
2. Partition
3. Demountable Refrigerator Unit
4. Demountable Desk



The Dana Warp Mills took advantage of Life-Line Gearmotors' compactness and operating efficiency. Shown is a Life-Line Gearmotor driving a delivery roll on a slasher.

Close-Quarter Servicing No Problem when your drive is a Westinghouse Gearmotor

Powering equipment at the Dana Warp Mills meant putting compact and dependable drive units into cramped quarters. To meet space limitations, designers carefully selected gearmotors with minimum size and definite servicing advantages . . . they specified Life-Line Gearmotors.

Integral design of Life-Line Gearmotors provides maximum saving in space and means no intricate coupling or alignment problems.

Inspection and servicing of Life-Line Gearmotors is simple. Sight gauges on both sides of gear case enable quick detection of oil level. The gear case is split horizontally and by removing a few bolts, the gear cover can be lifted clear of the unit. This simple operation makes all working parts accessible without draining oil or disturbing the unit mounting. Machine alignment remains true.

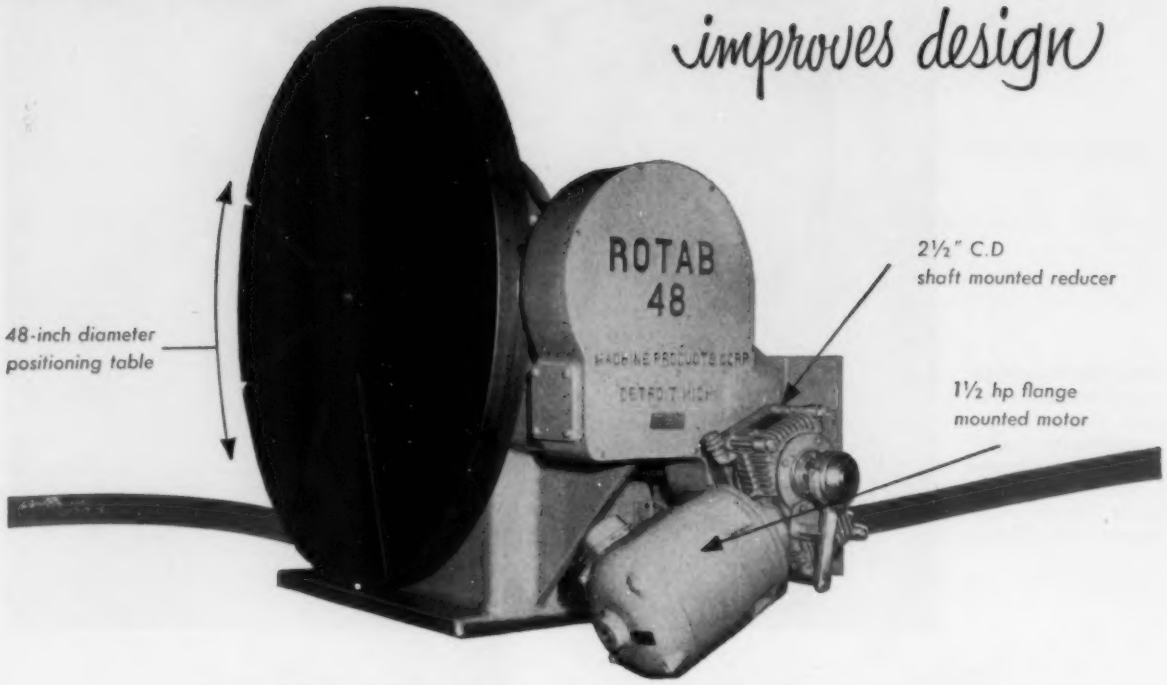
Life-Line* motor features and tough, precision-made Westinghouse gears combine to give Life-Line Gearmotors lasting stamina, even on the most rugged jobs.

For detailed information, write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-07323

*Trade-Mark

YOU CAN BE SURE... IF IT'S Westinghouse

ROTAB - too - improves design



WITH HIGH CAPACITY, SPACE AND WEIGHT SAVING CONE-DRIVE SHAFT MOUNTED SPEED REDUCERS

Yes, Cone-Drive shaft mounted speed reducers save weight and simplify design because of their unique double-enveloping worm gears. Three standard sizes currently available from stock, 2, 2½ and 3 inch center distance, in pinion under, pinion over or vertical shaft models enable you to pick the right reducer for your application. Standard reduction ratios range from 5:1 to 60:1 with additional speed reductions readily available when the motor is connected to the input shaft with vee belts or pulleys.

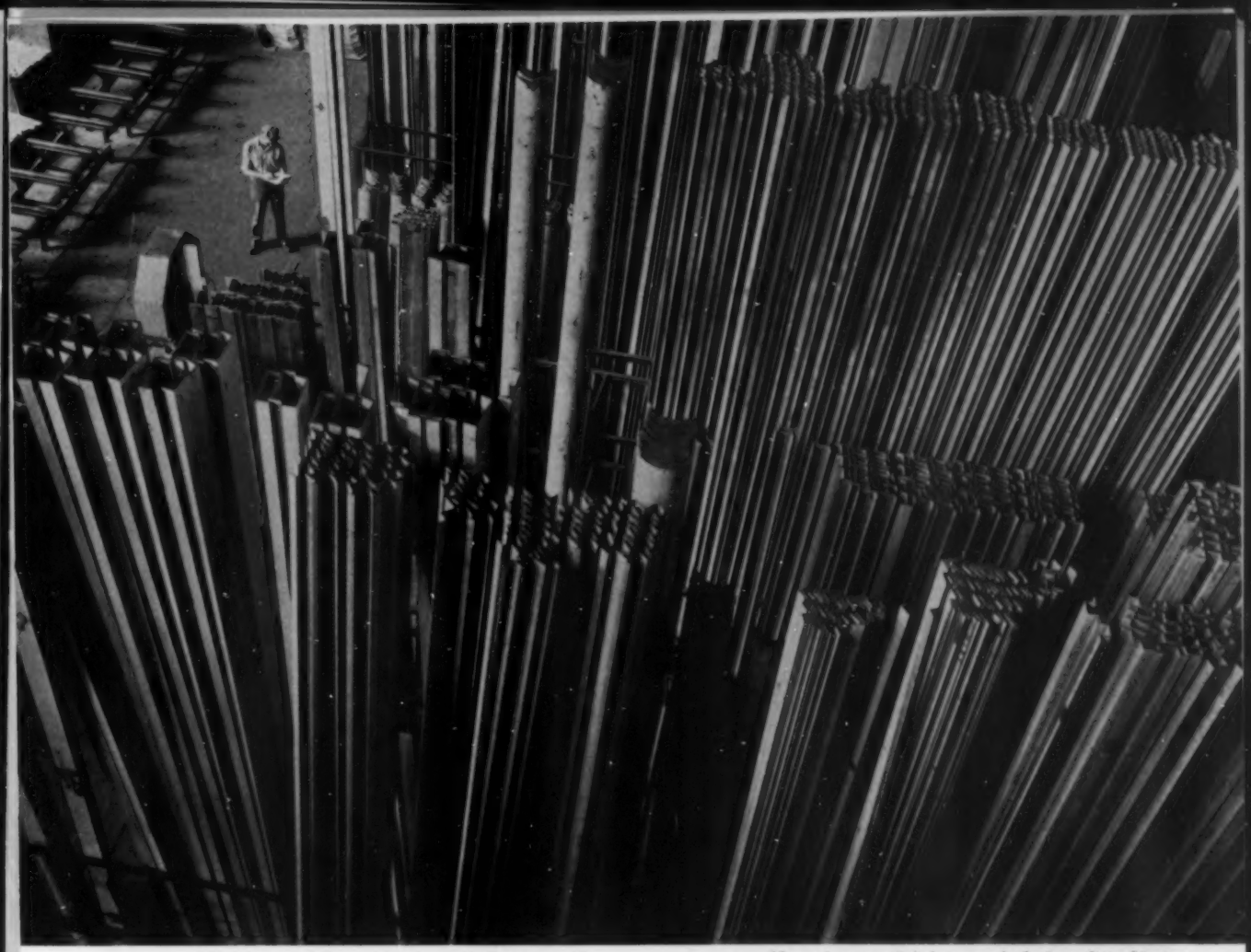
Machine Products Corp., Detroit, improved its 36 and 48-inch diameter Rotab precision positioning tables with motorized Cone-Drive shaft mounted speed reducers. These were added to the two Cone-Drive gearsets already used on the Rotab to give fast, smooth table tilting and eliminate operator fatigue when the table is operated continuously for precision checking or machining.

You too, can improve your product's performance, cut manufacturing costs, simplify maintenance and streamline its appearance with a space saving Cone-Drive shaft mounted speed reducer, motorized or standard drive. For motorizing, a bell housing accommodates standard NEMA C-type flanged motors.

COMPLETE ENGINEERING DETAILS ARE AVAILABLE IN BULLETIN CD-323. IT'S FREE FOR THE ASKING.

MORE HP PER POUND • MORE HP PER CUBIC INCH • MORE HP PER DOLLAR

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan



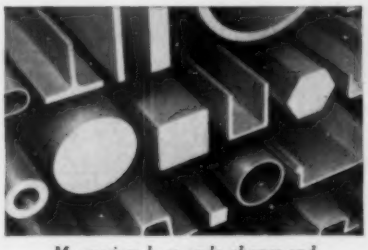
Magnesium extruded shapes ready for immediate shipment.

a new look at Magnesium!

NEW AVAILABILITY... SHAPES AND LENGTHS NEVER BEFORE EXTRUDED

Designers and cost-conscious production men have found the answer to their problems in many applications with magnesium extrusions—now produced by new Dow facilities. Standard and special shapes, bars, rods and tubing—all are readily available in alloys which save weight, add strength, cut costs. Get information on magnesium from your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Midland, Michigan.

Inspector checking special extruded shapes offered in a wide variety of alloys and sizes.



Magnesium bars, rods, shapes and tubing. Available in diameters or cross sections up to 10 inches.

World's first 84-inch magnesium coil mill now rolls sheet and plate in greater lengths and widths.

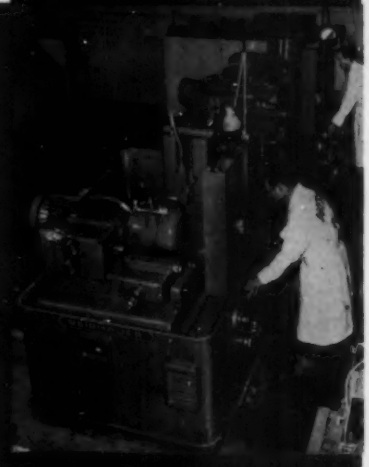
This coil of magnesium sheet started through the 84-inch coil mill as a one-ton rolling ingot.

Tenth Annual Meeting, The Magnesium Association, St. Louis, Mo. November 15-17

you can depend on DOW MAGNESIUM

DOW

"As accurate gears as can be made by man!"



WESTERN GEAR

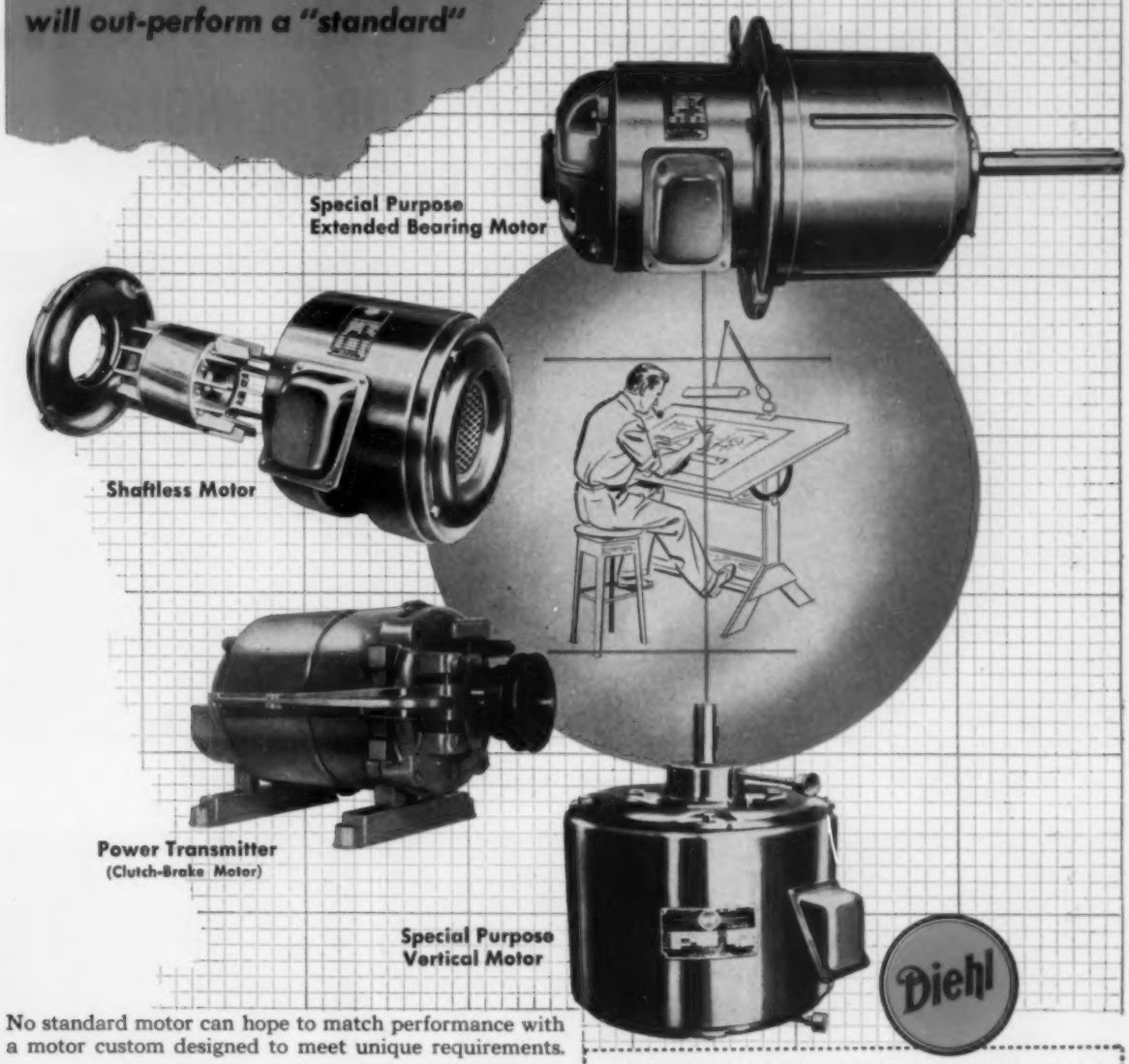
WESTERN GEAR WORKS

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

PACIFIC GEAR & TOOL WORKS · SOUTH WESTERN GEAR WORKS

a motor designed for its job

will out-perform a "standard"



No standard motor can hope to match performance with a motor custom designed to meet unique requirements.

That's why Diehl lays so much emphasis on custom construction . . . why, through the years, it has geared its abilities and its facilities, its design, engineering and manufacturing functions for maximum cooperation with its customers . . . whatever the application.

DIEHL **custom-tailored motors can:**

Cut costs • Save space • Reduce weight • Improve safety
Simplify design • Speed production • Improve appearance

When you want a fast, thorough answer to an unusual motor problem it will pay you to consult Diehl. Name your conditions . . . Diehl will design and build to match.

DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING COMPANY
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Please send me the following bulletins:

☐ New Type "D" Motor Bulletin No. PE-3304
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when you design aluminum parts requiring

WELDING or BRAZING...

THERE IS NO SUBSTITUTE FOR REYNOLDS EXPERIENCE AND FACILITIES

You can design any welded aluminum parts for your products with confidence because Reynolds Aluminum Fabricating Service can produce these parts and produce them efficiently and economically to your specifications. Reynolds years of day-in, day-out welding and brazing on a wide variety of jobs—plus continuous developments and experimentation in the use of welding and brazing equipment and techniques—assure you the very highest quality welded and brazed parts.

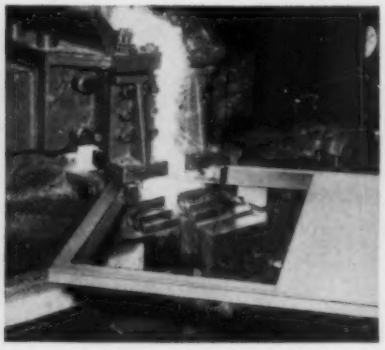
Look at the photos on these pages. Note the variety of Reynolds welding and brazing operations. Reynolds offers welding equipment ranging from 30 to 800 amp., like the automatic fusion welding equipment shown at right capable of continuous welding up to 63 inches per minute and featuring built-in crater fillers that permit crater-free welding. Remember, too, Reynolds constant quality control minimizes "down time"—cuts your costs.

For full details on these operations and on the many other services offered by Reynolds Aluminum Fabricating Service, call your Reynolds office listed under "Aluminum" in your classified telephone directory or write Reynolds Aluminum Fabricating Service, 2061 So. Ninth St., Louisville 1, Kentucky.

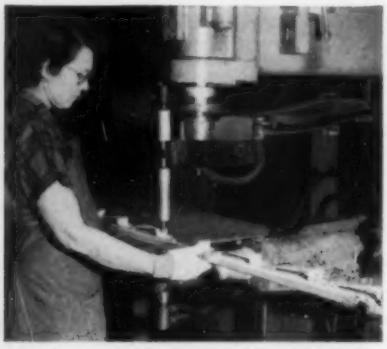
Write for your copy of the new 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.

SEE "Mister Peepers", starring Wally Cox, Sundays on NBC-TV

Flux coated metal-arc welding in a Reynolds plant.



Reynolds plant photo showing flash welding of aluminum.



Spot welding clips to roll formed patio awning beam in a Reynolds plant.

REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING

Reynolds automatic fusion welding equipment. Small photo shows finished trailer wheel welded on this equipment in a Reynolds plant.

Inert-gas-shielded arc welding on aluminum tubing in a Reynolds plant.

A conveyorized brazing furnace in a Reynolds plant.

FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

NEW

Here's your guide to

SAVINGS with NEW

Standardized BOSTON Gear Products — from STOCK

NEW

Certified

BEAR-N-BRONZ Solid Bronze Bearings

A complete line — 768 stock sizes of Standard Bearings — 221 stock sizes of Cored Bars — 35 stock sizes of Solid Bars. CERTIFIED Highest Quality, with a MONEY-BACK offer.

NEW

SPROCKETS Larger, heavy duty SHOLD-A-GRIP Interchangeable Tapered Sprockets and Bushings

Sprockets up to 24" pitch dia. — and Bushings to fit shaft sizes from ½" to 3" by 16ths. Also, more sizes available in conventional sprockets.

NEW

BOST-BRONZ BEARING BANK

A sturdy metal kit, with 47 common sizes of Bost-Bronz oil-impregnated bearings, from which 313 standard sizes can be cut with a hacksaw — means you have any bearing you need *on hand* in any emergency. Saves 50% over buying same bearings separately.

20 SHAFT SIZES UP TO 2 7/16"

NEW

PILLOW BLOCKS and Flanged Cartridges in larger sizes

ADDED TO FORMER ½" TO 1¼" RANGE

Now, precision Type ABEC No. 1 Classification Bearings in a stock size range for 27 shaft sizes from ½" to 2 7/16", fully self-aligning.

NEW

20° PRESSURE ANGLE SPUR GEARS in a full range of stock sizes

Off-the-shelf delivery on 20 pitch to 4 pitch with pitch diameters from .6" to 40". Save 20% in weight — space — cost.

NEW PRODUCTS Catalog NP-55

lists full specifications of these new Boston Gear products and many others in 196 pages. Get your copy . . . use it with your BOSTON Gear General Catalog No. 55 . . . for up-to-the-minute information on the products that make BOSTON Gear first choice of cost-wise buyers.

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3-PIECE JAW COUPLING with BOST-BRONZ insert

BOST-BRONZ oil-impregnated Bearing cushions torsional load, resists wear from any rubbing friction . . . 17 stock sizes, with hole diameters from 3/16" to 1½".

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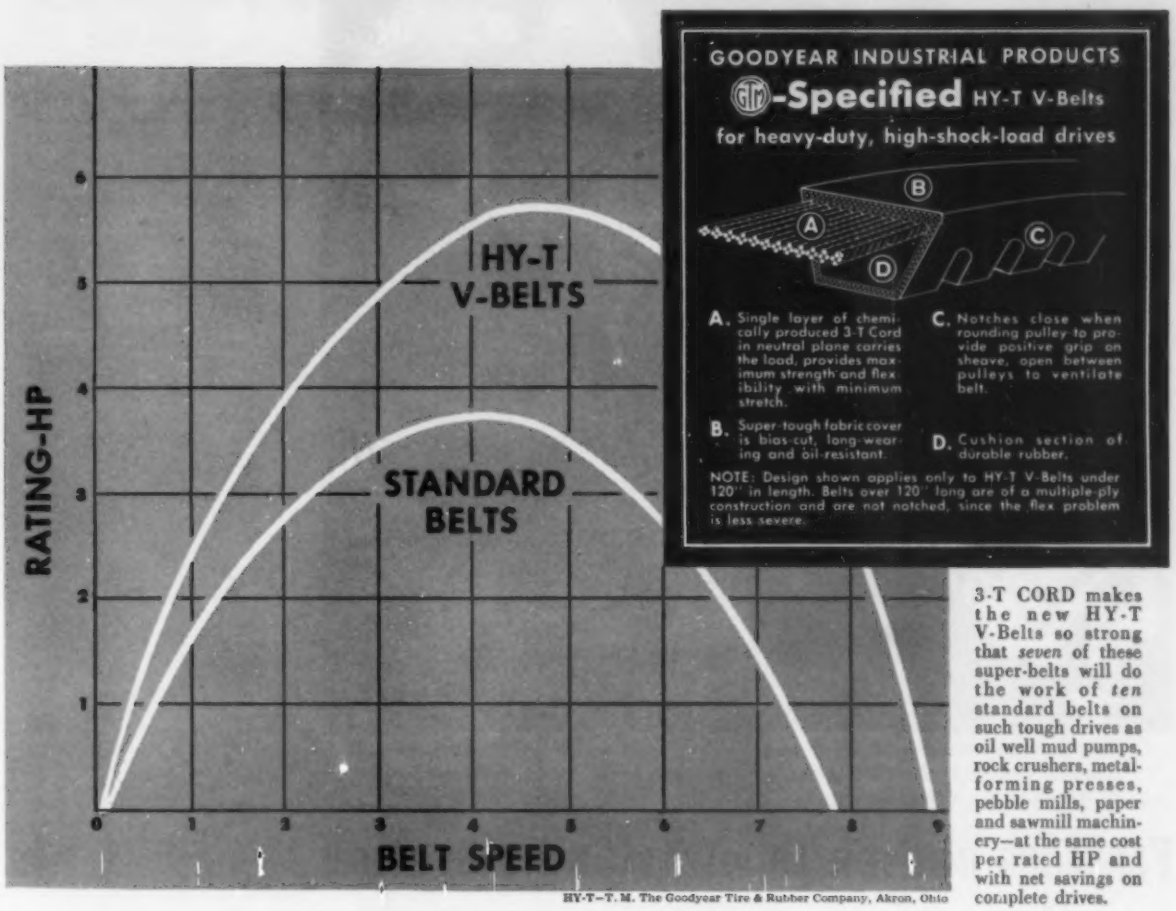
DISTRIBUTOR

Look under "Gears" in the Yellow Classified Section of your Telephone Directory for the BOSTON Gear Distributor nearest you. Catalog NP-55 also available from Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

TRIPLE-TEMPERED (3-T) CORD

makes new, super-V-belt possible


RATING-HP
BELT SPEED
HY-T V-BELTS
STANDARD BELTS
0
1
2
3
4
5
6
7
8
9
GOODYEAR INDUSTRIAL PRODUCTS
GM-Specified HY-T V-Belts
for heavy-duty, high-shock-load drives
A
B
C
D
A. Single layer of chemically produced 3-T Cord in neutral plane carries the load, provides maximum strength and flexibility with minimum stretch.
B. Super-tough fabric cover is bias-cut, long-wearing and oil-resistant.
C. Notches close when rounding pulley to provide positive grip on sheave, open between pulleys to ventilate belt.
D. Cushion section of durable rubber.
NOTE: Design shown applies only to HY-T V-Belts under 120" in length. Belts over 120" long are of a multiple-ply construction and are not notched, since the flex problem is less severe.

HY-T—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

3-T CORD makes the new HY-T V-Belts so strong that *seven* of these super-belts will do the work of *ten* standard belts on such tough drives as oil well mud pumps, rock crushers, metal-forming presses, pebble mills, paper and sawmill machinery—at the same cost per rated HP and with net savings on complete drives.

40% HIGHER HORSEPOWER RATING without sacrifice of service life. Much higher shock-resistance. Minimum stretch. Long flex-life. Dimensional stability under all storage and operating conditions. Maximum resistance to oil, moisture, mildew and static generation. These are the properties built into the new HY-T V-Belt by the G.T.M. — Goodyear Technical Man — with the help of Triple-Tempered (3-T) Cord.

3-T Cord is the result of an exclusive and patented Goodyear process—a triple-action tempering of special synthetic cord, involving Tension, Temperature and Time, which "sets" the cord at its point of maximum strength and resilience. Using this super-strong cord as the load-carrying member, the G.T.M. built a completely new super-V-belt of completely balanced construction.

The HY-T V-Belt is designed for service on heavy-duty, high-shock-load drives or on drives where limited space previously resulted in underbelting. On such drives it has been thoroughly proved to give longer life than standard fabric belts with appreciable savings in drive and maintenance costs. For details on the super-rated HY-T V-Belt see the G.T.M. or your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Akron 16, Ohio.

YOUR GOODYEAR DISTRIBUTOR *can quickly supply you with Hose, Flat Belts, V-Belts, Packing or Rolls. Look for him in the yellow pages of your Telephone Directory under "Rubber Products" or "Rubber Goods."*

GOODYEAR

THE GREATEST NAME IN RUBBER

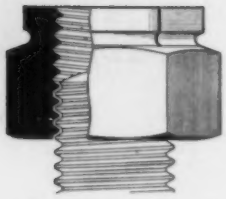
This portable electric hammer is completely self-contained. So are the one-piece, all-metal FLEXLOCs that hold it together, even under the intense impact vibration induced by the rapid hammering action.

FLEXLOCs chosen to withstand vibration of 3000 hammer blows per minute

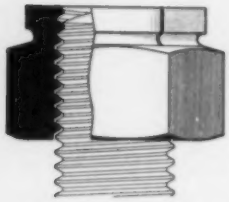
The manufacturer of this portable electric hammer reports, "FLEXLOC Self-Locking Nuts have solved our problem of obtaining a desirable fastener, because they withstand the terrific vibration induced by the impact of 3000 hammer blows per minute without working loose."

This portable electric hammer is subjected to terrific impact-induced vibration. The fasteners that hold it together must take the same beating. The FLEXLOCs were selected only after numerous fastening devices had been tested. Two ¼"-20 nuts hold the fastening bolts securely in position on the forward end of the hammer. One 1"-14 nut prevents loosening of the components at the nose.

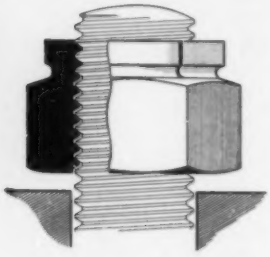
You can get FLEXLOCs of various types and materials in a wide range of sizes and in any quantity. And these one-piece, all-metal locknuts are carried in stock by leading industrial distributors everywhere. See your FLEXLOC distributor or send for literature and samples. STANDARD PRESSED STEEL CO., Jenkintown 28, Penna.



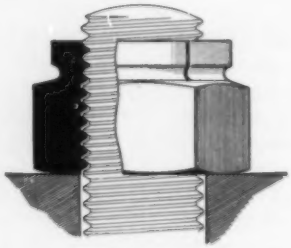
Starting. A FLEXLOC starts like any ordinary nut. Put it on with your fingers. Tighten it with a standard hand or speed wrench.



Beginning to Lock. As the bolt enters the segmented locking section, the section is expanded, and the nut starts to lock.



Fully Locked As a Stop Nut. When 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC is fully locked. A FLEXLOC does not have to seat to lock.



Fully Locked As a Seated Nut. When it is used as a lock or stop nut, the locking threads of the FLEXLOC press inward against the bolt, lifting the nut upward and causing the remaining threads to bear against the lower surface of the bolt threads. Vibration will not loosen a FLEXLOC, yet there is no galling of threads.

FLEXLOC LOCKNUT DIVISION

SPS
JENKINTOWN PENNSYLVANIA

Startling Facts

ABOUT MOTOR BEARING LUBRICATION

FREE!.....THIS FULL-COLOR PROFUSELY ILLUSTRATED BOOKLET OF FACTS THAT HAVE A BEARING ON THE LIFE OF YOUR MOTORS

Comparisons of methods for lubricating electric motors are interestingly depicted in this new booklet. It illustrates the three principal types of bearing systems used in motors – cartridge, one-side lubrication and Lubriflush – with explanations of the functions of each. For demonstrating the action of re-lubrication in the U. S. Lubriflush bearings, a transparent bearing housing is dramatically illustrated by a series of natural color photos. Proof that any motor bearing breathes air and therefore leads to contamination of the bearing is photographically demonstrated to indicate the necessity of lubrication every year or so. Excerpts of statements by leading bearing manufacturers about the necessity of motor lubrication are presented. This informative educational booklet, edited by lubrication engineers, is full of startling facts you should know. Write today for a complimentary copy. Simply fill in the Coupon below.

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☐ Lubriflush Booklet #1848

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Company_____
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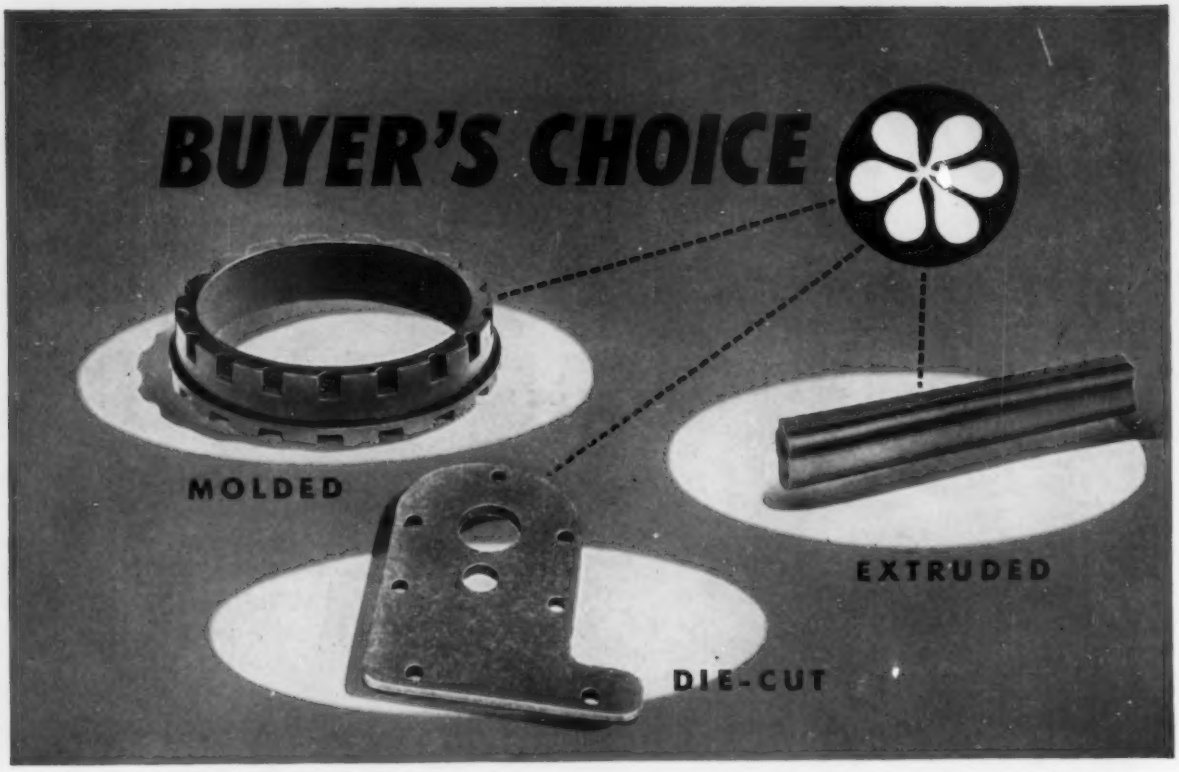

*ACADIA SYNTHETIC RUBBER PARTS ARE MADE ALL 3 WAYS!

With Acadia you have a *choice!* Not only molded rubber . . . not only molded and die-cut . . . not only extruded rubber . . . but rubber parts any way you require! Better yet, Acadia uses whatever method the requirements of the job and you dictate is the *best* way to do it.

Acadia is especially sensitive to your specifications. We will process synthetic components for oil-resistance—good aging properties—resistance to heat—any characteristic you're seeking, or a combination of characteristics. Acadia parts are cut, molded or extruded to all required shapes, sizes and types, with almost unlimited applications.

Also, we offer Acadia SILICONE Rubber, molded or extruded for gaskets, seals, "O" rings, washers, sheets, cut-parts and packings. This is the rubber that will stay resilient at 100° *below* zero, or 500° above!

There's an Acadia Sales Engineer near you to serve you. Write us today, and we'll put him in touch with you immediately.

ACADIA Synthetic PRODUCTS

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QUALITY IN
ALUMINUM COILED
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CIRCLES & BLANKS . . .
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REVERE!

AVAILABLE IN ALLOYS
2S • 3S • 4S • 50S • 52S

Coiled and flat sheet up to 36" wide and .060" thick, as well as circles and blanks.

For 153 years Revere has been rolling non-ferrous metals, and for more than 30 years has been fabricating aluminum. Out of this long background have come the superior Revere aluminum sheet products, as well as a system of quality control that emphasizes the specific requirements of each customer, plus the equipment and experience to fabricate the product accordingly.

Not only for aluminum sheet products, but also for aluminum seamless drawn tube, extruded products, electrical bar and forgings, it will pay you to come to Revere first. And for help with difficult problems, always feel free to call upon Revere Technical Advisory Service.

All users of aluminum should become acquainted with the new, uniform alloy designation system adopted by The Aluminum Association, which will go into effect during the last quarter of 1954. Following are the old and new designations applying to the Revere Aluminum Alloys. Write us for pamphlet on the subject.

OLD								
2S	3S	4S	24S	50S	52S	61S	62S	63S
NEW								
1100	3003	3004	2024	5050	5052	6061	6062	6063

REVERE COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
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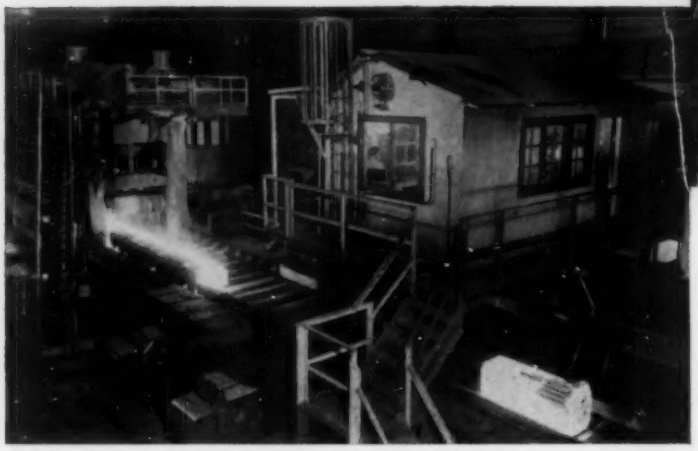
Trabon

AUTOMATICALLY LUBRICATES YOUNGSTOWN MILL

. . . . . and cuts MAINTENANCE *to the bone!*



After the first four months of operation, the only maintenance on TRABON'S automatic lubrication system, recently installed on the Youngstown Sheet & Tube Company's 44" blooming and slabbing mill, was the replacement of two hoses in an unusually hot spot.

Bearings were in good shape after the rolling of 238,100 tons. Everyone was pleased with the production record.

We were, too, because this installation proved once again that a Trabon system can deliver just the right amount of oil or grease at just the right time in exactly the right place.

And a Trabon system does this job under the worst possible operating conditions . . . dirt, steam, ice, heat . . . *positively!*

What's YOUR lubrication problem? Write for our current detailed literature.

Pertinent FACTS

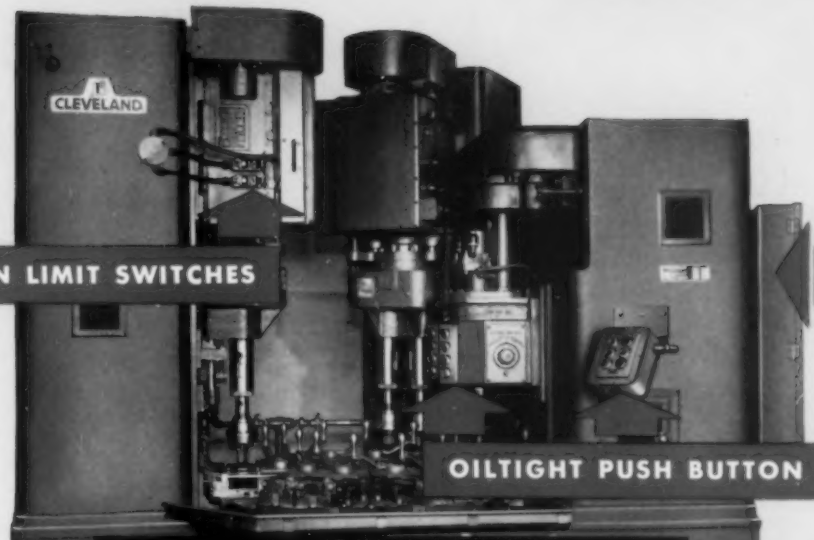
- **Automatic oil system lubricates screws, breaker blocks and nuts.**
- **Automatic grease system lubricates roll necks and chuck slides; front and rear table drives, manipulator and feed roll bearings in mill housing.**
- **All pumps in cellar.**
- **Control boxes in engine room.**
- **Lights and warning horns included.**

TRABON automatic lubrication has a *BEARING* on the subject of production

Trabon ENGINEERING CORPORATION

1814 E. 40th STREET • CLEVELAND 3, OHIO

Oil and Grease Systems



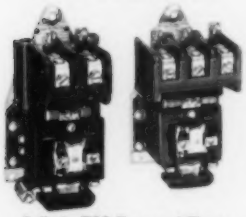
PRECISION LIMIT SWITCHES

SPECIAL CONTROL PANEL

OILTIGHT PUSH BUTTON STATIONS

Quality MOTOR CONTROLS for Automatic Machines

Bulletin 709
Solenoid Size 3 Starter



Bulletin 702 Two and Three
Pole Size 1 Contactors

Bulletin 350 Drum Switch
for Flush Mounting

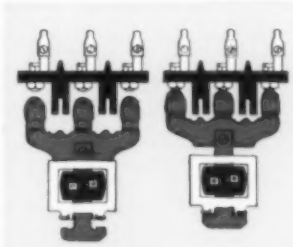
Bulletin 800T Oiltight
Selector Switch

When you sell your machines fully equipped with automatic motor controls, make these controls a featured sales asset. Standardize on a line . . . like ALLEN-BRADLEY . . . having a world-wide reputation for QUALITY . . . and you can guarantee "complete" customer satisfaction.

Independent industry-wide surveys list ALLEN-BRADLEY controls at TOP preference among machinery users. In test after test ALLEN-BRADLEY motor controls are the first choice of designers, shopmen, and electricians. They like the simple A-B design and trouble free operation. They like the fine A-B appearance. They like the big line of A-B accessory controls that solve so many control problems so easily. They like the all around A-B "Quality."

We shall be glad to send you the Allen-Bradley Handy Catalog. Please write for your copy, today.

The reason for the trouble free performance of Allen-Bradley solenoid starters is the simplicity of design. There is but ONE MOVING PART . . . the ONE PIECE solenoid plunger which carries the double break moving contacts (shown in red).

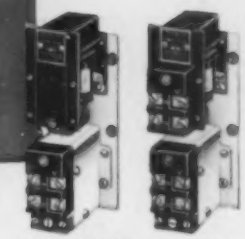


SIMPLE—
Only One Moving Part

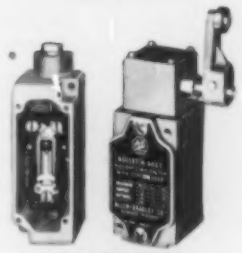
The double break fixed contacts are mounted in the molded contact block (shown in black).

The cadmium silver moving and stationary contacts need no filing, cleaning, or dressing. They are good for millions of switching operations.

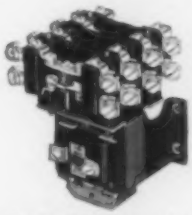
Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Limited—Galt, Ont.



Bulletin 849 Pneumatic Timer
Adjustable—1/6 to
180 Seconds



Bulletin 801-802T
Limit Switches



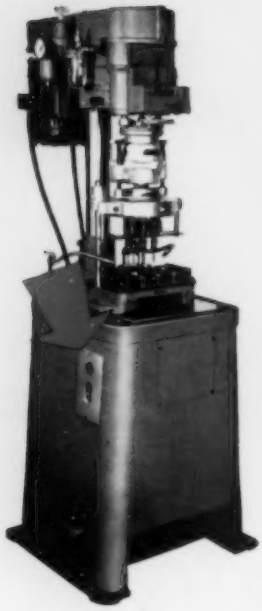
Bulletin 700 Universal A-C
4-Pole Relay

Bulletin 892 Terminal Blocks
for Special Control Wiring

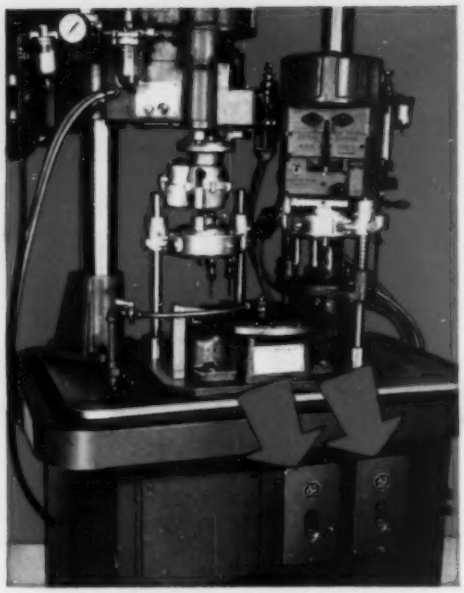
ALLEN-BRADLEY
TROUBLE FREE MOTOR CONTROLS
QUALITY

A-B Quality

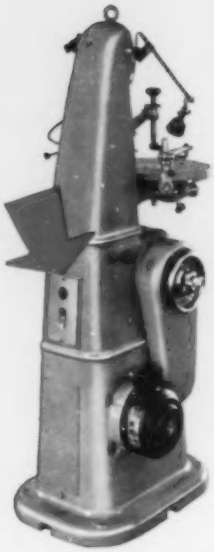
9-54-R



Ettco single spindle tapping machine with manual flush starter.



Ettco multiple spindle drilling and tapping machine with two Allen-Bradley Bulletin 609 manual flush type motor starters.

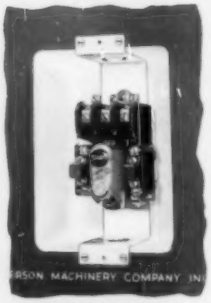


Williams punch and die making machine with A-B flush type starter.

Improve the appearance of your machines with A-B flush type motor starters

When contemplating the design of a new machine, take advantage of the opportunity to "streamline" your design by recessing into the base of the machine at least the starter—and perhaps this can also be done with the motor.

Look at the trim appearance of the three motorized machines shown above. Note how the designers have provided recessed cavities for flush type Allen-Bradley Bulletin 609 manual motor starters.



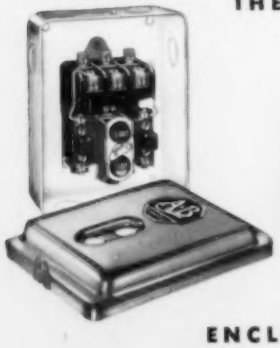
Bulletin 609 manual starter in machine base

These flush type motor starters give a smooth, modern appearance to the machines and, therefore, provide a "sales value" that can be used to advantage.

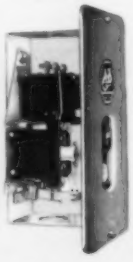
Allen-Bradley Bulletin 609 manual starters, Bulletin 709 automatic starters, and Bulletin 712-713 combination starters can be furnished in several types of flush mountings. They are fully described in the Allen-Bradley Handy Catalog. Send for a copy, today.

THE LINE OF BULLETIN 609 MANUAL STARTERS

General purpose with white interior



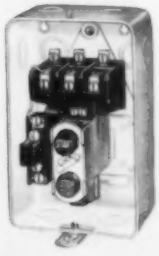
Flush type



Weatherproof & waterproof

Explosion proof

Single phase



ENCLOSURES FOR EVERY OPERATING CONDITION

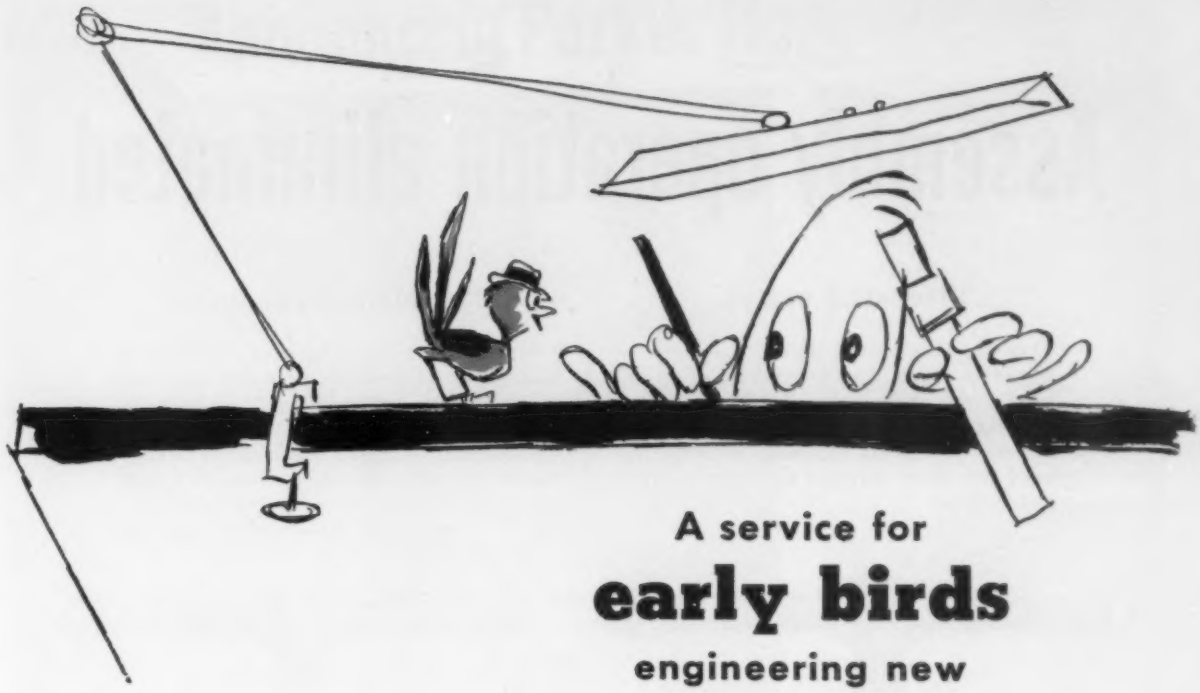
9-54-R

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. In Canada—Allen-Bradley Canada Limited—Galt, Ont.

A-B Quality

ALLEN-BRADLEY

BULLETIN 609 QUALITY MANUAL STARTERS



A service for

early birds

engineering new metal products

...early birds
are sheet metal design engineers and production men who make a point of getting the gremlins out of new products or new models in early stages...

Are you an EARLY BIRD? Then here's a new service to help you bring new products in on the beam.

First step is to take your design to engineers in National Lead's Tool & Stamping Department.

They'll check for production bugs and ways to cut costs. Then they'll cast try-out tooling in "Kirksite" A or "Nalcolite" plastic and stamp out components ... making any indicated changes.

If you need pilot models, they'll assemble them too.

Once you're satisfied with dies, parts, and pilot models, National Lead turns the try-out tooling over to you ... for medium-run production or for duplication in steel tooling for very long runs.

Before full scale production is set up, most of your worries are over.

Have you a new design on the boards? Do you want more details on this new Tool & Stamping Department Service? Then just sing out.

TOOL & STAMPING DEPARTMENT

National Lead Company 900 West 18th Street Chicago 80, Illinois

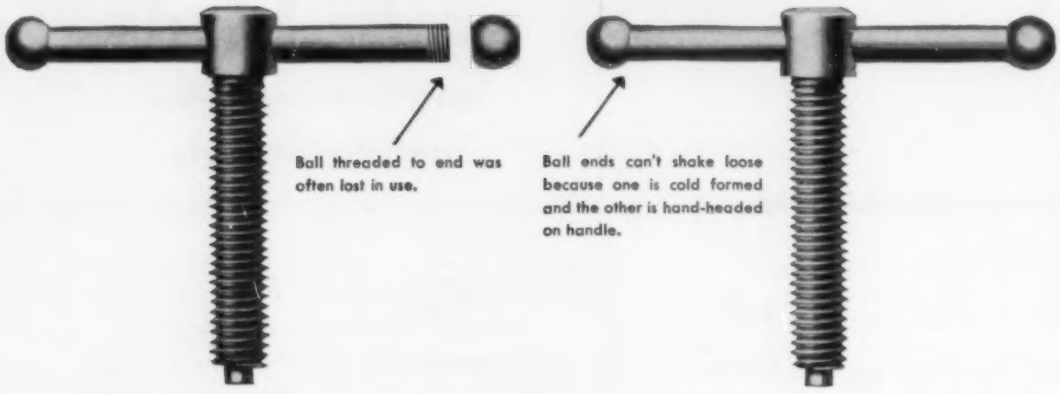
Assembly operation eliminated

The old way:

This vise handle was originally cut from bar stock by screw machine. One end of the handle was threaded while the other was machined to a ball head. To complete the assembly a separate internally threaded ball head had to be screwed onto the threaded end by hand.

The National way:

Our "Special Products Service" showed how this vise handle could be produced faster and at lower cost by cold heading. The handle and one head were cold formed to required dimensions. Then, the handle was inserted through the drilled hole in the head of the jaw adjusting screw and the other end was hand headed. Result . . . substantial savings in material and production costs.



Ball threaded to end was often lost in use.

Ball ends can't shake loose because one is cold formed and the other is hand-headed on handle.

Bring your "Special" problems to National

National has the experience and wide range of cold heading equipment needed to solve many "special" problems. Our "Special Products Service" representative will be glad to study your requirements. Write for free copy of National's "Special" fastener booklet.

REPRESENTATIVES IN:

Chicago	Kansas City, Mo.	Philadelphia
Cincinnati	Lansing	Rochester
Denver	Milwaukee	San Francisco
Detroit	Minneapolis	Seattle
Indianapolis	New York	St. Louis

THE NATIONAL SCREW & MFG. COMPANY

Cleveland 4, Ohio

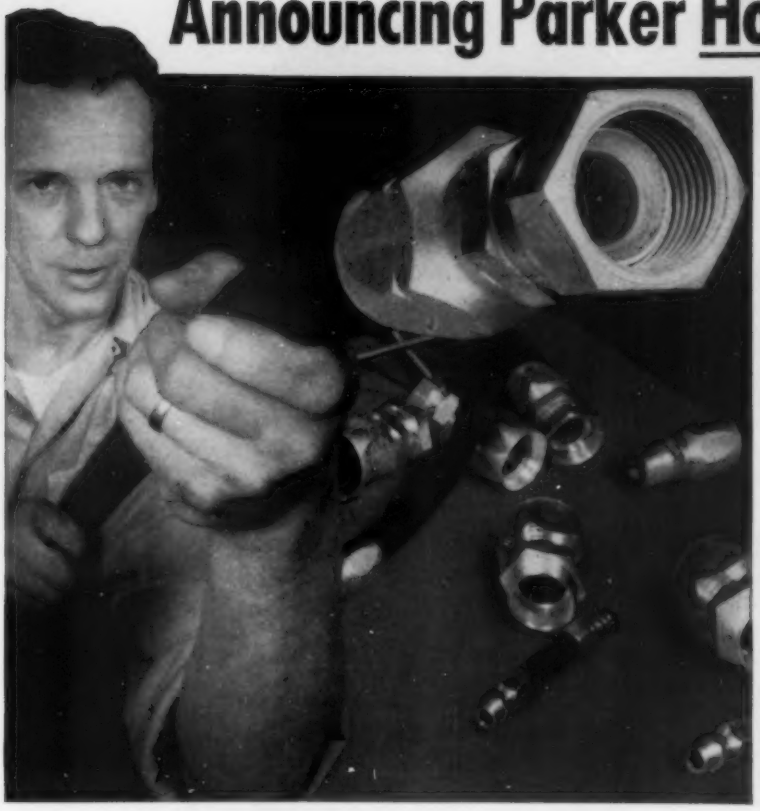
Pacific Coast: National Screw & Mfg. Co. of Cal.
3423 South Garfield Ave., Los Angeles 22, Cal.

MANUFACTURERS OF PHILLIPS SCREWS

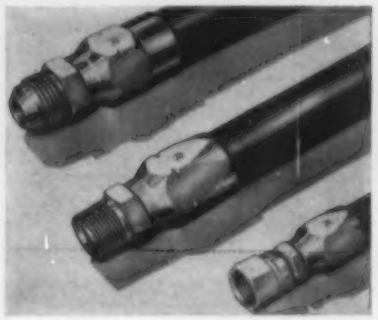
National PRODUCTS

Fasteners Hodell Chains Chester Hoists

Announcing Parker Hoze-lok Fittings



S.A.E. Standards for hydraulic hose and fittings are fully met by Parker *Hoze-lok* fittings. See S.A.E. Handbook pages 725 to 730. Or, mail coupon for reprint.



3 styles: for cotton-covered or rubber-covered single-wire hose in medium pressure service; for rubber-covered, double-wire hose in high-pressure service.

Use Parker Hoze-lok fittings for better performance, easier make-up, greater re-usability and economy

New Parker *Hoze-lok* fittings and hose assemblies, for medium and high-pressure hydraulic service, offer longer, trouble-free performance. The deep socket recesses provide an unusually large gripping area. Fittings won't pull out.

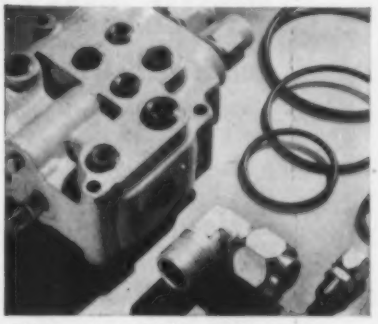
Hoze-lok conforms to S.A.E. Hydraulic Hose and Fittings Standards and to hose fitting specifications of J.I.C. Hydraulic Standards.

These new fittings make up easier . . . saving time and temper of assemblers. Socket thread is larger than braid diameter, making it easier to insert the hose end into the socket. Contour of the socket provides greater wrench clearance at hex of nipple.

Greater re-usability of *Hoze-lok* fittings cuts costs. Parts of old hose lines can be salvaged, fittings detached and re-used. You don't need large inventories—just a small stock of bulk hose and *Hoze-lok* fittings.

Hoze-lok fittings are augmented by *Triple-lok* (tube fitting) connecting adapters. Mail the coupon for *Hoze-lok* Catalog No. 4400.

TUBE AND HOSE FITTINGS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio



What other Parker products interest you? *Triple-lok* flare tube fittings? *Ferulok* flareless tube fittings? New hydraulic control valves? Parker O-rings?

TUBE AND HOSE
FITTINGS DIVISION
Section 409-L
The Parker Appliance Co.
17325 Euclid Avenue
Cleveland 12, Ohio

☐ Please send *Hoze-lok* Catalog 4400
☐ Reprint of S.A.E. Standards Bulletin 440581

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Company_____
Address_____
City_____ State_____

Parker
Hydraulic and fluid system components

Silicon steel laminations give high efficiency.
Hardened beryllium copper plunger guide reduces friction and wear.
Shock-absorbing bumpers cushion stroke, assure longer service.
Heavy Formvar insulated magnet wire on high flow point molded nylon bobbin.
Tempered steel spring absorbs vibration — holds assembly firmly in alignment.

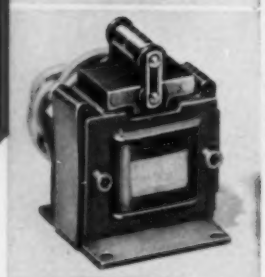
Decco INDUSTRIAL SOLENOIDS

THE *Dependable* ANSWER TO YOUR SOLENOID PROBLEMS

- COMPACTLY DESIGNED—for powerful performance.
- SHOCK-MOUNTED—Reduces self-destruction—greatest cause of solenoid failure.
- HIGH MOISTURE RESISTANCE—Thoroughly impregnated with insulating baking varnish.
- ALTERNATING CURRENT TYPES—Welded base construction for horizontal mounting. Welded or shock-mounted base for vertical mounting. Available in standard voltages, push or pull types, J. I. C. specifications.
- DECCO D.C. SOLENOIDS—are *NOT* MODIFIED AC SOLENOIDS. They deliver a tremendous force in a small space—ideal for mobile equipment.
- WAFER-TYPE SOLENOIDS—Dependable, small, short stroke, low amperage, push or pull solenoids for small mechanisms and light valving.
- SPECIAL SOLENOIDS ENGINEERED TO YOUR PROBLEMS.

FOR COMPLETE INFORMATION ON ALL DECCO INDUSTRIAL SOLENOIDS • WRITE:

HORIZONTAL PUSH-TYPE— WELDED BASE



VERTICAL PULL TYPE— SHOCK-MOUNTED

VERTICAL PUSH TYPE— WELDED BASE

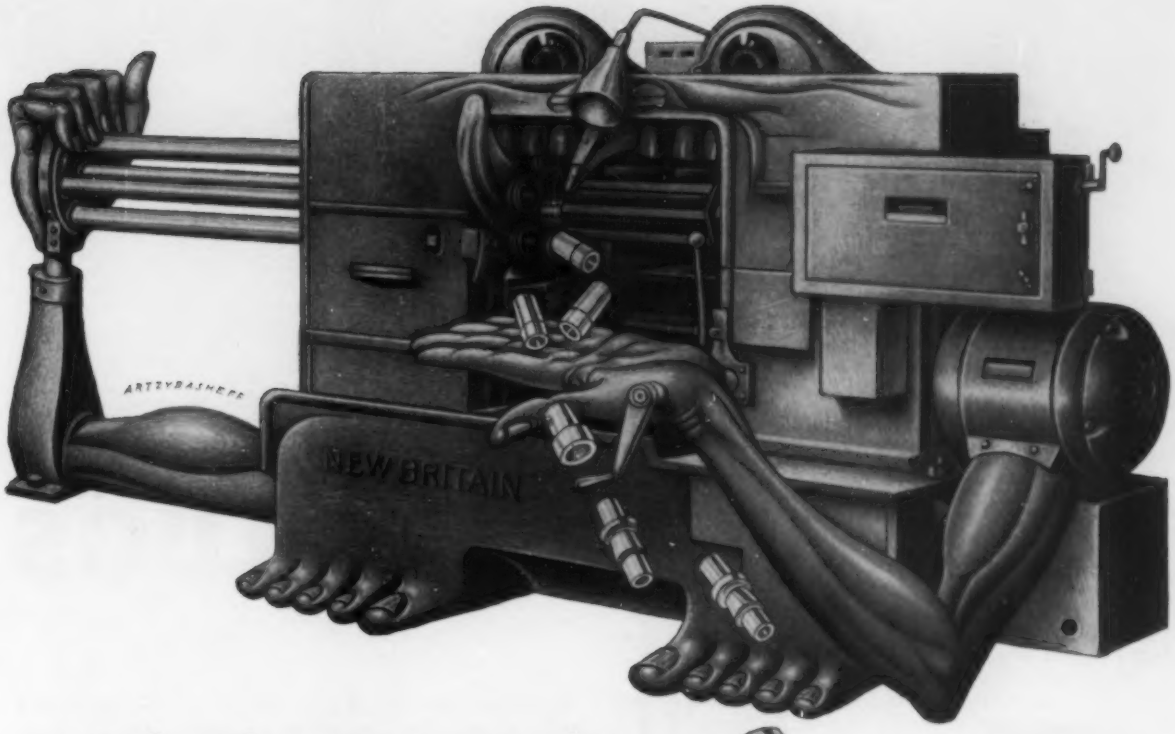
A C WAFER SOLENOID

D C INDUSTRIAL SOLENOID

Decco
THE HEART OF DEPENDABLE AUTOMATION EQUIPMENT

DETROIT COIL COMPANY

2435 HILTON ROAD, FERNDALE 20, MICHIGAN



Look what you can do with Alcoa® Aluminum on your New Britain automatic screw machines

Carriers on New Britain automatic screw machines lift automatically during index to eliminate all wear on locating surfaces. Forming slides, mounted on large-diameter, hardened cylindrical studs preserve initial accuracy and permit fast forming advances.

With Alcoa Aluminum Screw Machine Stock, you can operate your New Britains at top feeds and speeds and get fine surface finishes with consistently uniform tolerances. You can lower your piece costs as much as one-third. You get three times as many parts from a pound of aluminum as from a pound of the heavier metals. Aluminum takes all finishes—resists corrosion—conducts electricity and heat exceptionally well.

Find out how aluminum can help you. Contact your local Alcoa sales engineer whose office is listed under "Aluminum" in the classified section of your telephone directory. Or write ALUMINUM COMPANY OF AMERICA, 853-K Alcoa Building, Pittsburgh 19, Pa.

PRODUCTION AND DESIGN ENGINEERS will want two Alcoa booklets, *Alcoa Aluminum in Automatic Screw Machines* and *Corrected Tool Diameter Tables*. Also available at no extra cost are two precision computers —a Speed-Feed calculator, and an alloy property guide which shows at a glance the various properties of Alcoa Aluminum Screw Machine Stock.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

DESIGNED FOR:

LONG LIFE
MAXIMUM STRENGTH
POSITIVE SEAL
LOW COST

Lamson
FORGED STEEL
PIPE PLUGS

Lamson Pipe Plugs are available in the following sizes: ⅛", ¼", ⅜", ½" and ¾".

Have you checked the Pipe Plugs you are using lately? Like so many common but important parts to your product, Pipe Plugs are apt to be taken for granted with a resultant loss in production time and efficiency.

Lamson Pipe Plugs are FORGED for maximum strength and positive sealing. Heads will not chip or break under severe wrenching. This means savings for you on the production line. The ROLLED "DRYSEAL" THREADS of Lamson Pipe Plugs guarantee maximum toughness and correct tolerances are assured by Lamson's famous "Quality Control" system.

Yet, despite the extra protection and value Lamson Pipe Plugs offer, they cost no more than other types. You get true premium quality at a low "regular" price.

So next time specify Lamson Pipe Plugs—in steel, brass, bronze or aluminum—and give your product the extra advantage it deserves.

Lamson & Sessions

The LAMSON & SESSIONS Co.
1971 West 85th St. • Cleveland 2, Ohio
Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

FOR PROMPT DELIVERY AND HELPFUL SERVICE, ORDER FROM YOUR LAMSON DISTRIBUTOR

PLUG NUTS
Ideal for blind or hard-to-reach places.

PIPE PLUGS
Forged steel, heat-treated.

"1035" SET SCREWS
Cup point type, hardened and heat-treated.

PLACE BOLTS
With "Built-in" spring action for positive locking.

LOCK NUTS
Economical, vibration proof. Can be used repeatedly.

"BENT BOLTS"
Including U bolts, eye bolts, hook bolts, etc.

MACHINE SCREWS
Clutch and Phillips recessed head screws.

SEMS
Pre-assembled lockwashers on tapping and machine screws.

18 feeds, 18 speeds—plus lasting precision with TIMKEN® bearings

GREAVES MACHINE TOOL mounts the spindle of its Greaves milling machine on Timken precision bearings to insure lasting precision.

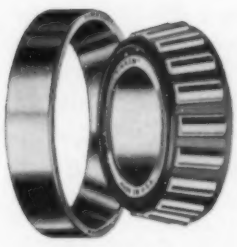
FOR 15 years, the Greaves Machine Tool Division of J. A. Fay and Egan Company have been assuring customers of lasting spindle precision by specifying Timken® tapered roller bearings for their machine tools. Typical example is this Greaves 2-H plain and universal milling machine which features 18 feeds and 18 speeds to provide the one best speed-feed combination for every type of work and material.

Used on the first and second intermediate shafts and on the spindle, Timken bearings take radial and thrust loads in any combination. Their tapered design makes this possible. Shafts are held in accurate alignment, assuring precision milling even after years of service. Line contact between rollers and races give Timken bearings extra load-carrying capacity.

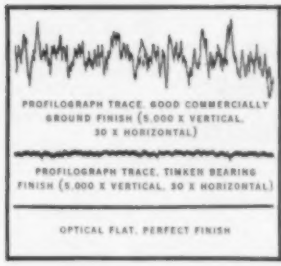
The geometrically correct design of Timken bearings gives them true rolling motion; their accuracy lives up to the design. Result: Timken bearings practically eliminate friction. And to get the quality of steel to meet our exacting specifications, we make our own. No other U. S. bearing manufacturer does.

Under normal usage, Timken bearings last the life of the machine. Specify them in machinery you buy or build. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



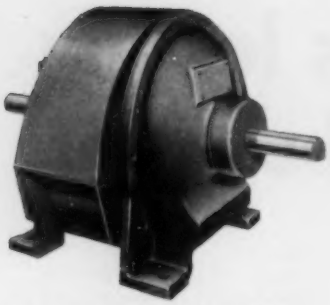
TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS


PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
OPTICAL FLAT, PERFECT FINISH

SMOOTH TO MILLIONTHS OF AN INCH

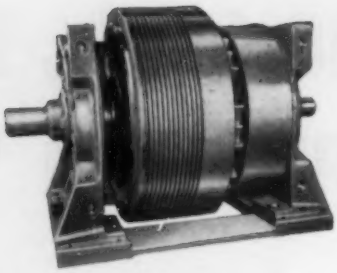
Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

NOT JUST A BALL — NOT JUST A ROLLER — THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST — LOADS OR ANY COMBINATION

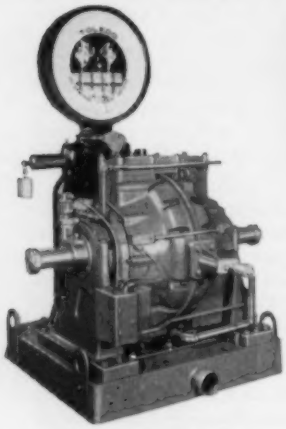


AIR COOLED COUPLINGS

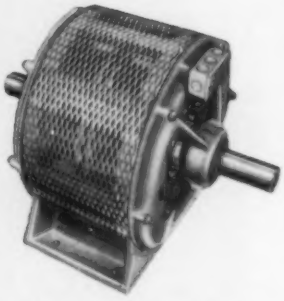
AJUSTO-SPEDE MOTORS



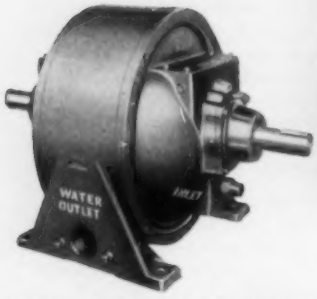
PRESS DRIVES



DYNAMOMETERS

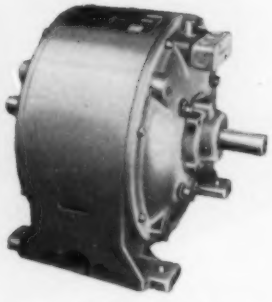


AIR COOLED BRAKES



LIQUID COOLED COUPLINGS

Our new booklet, "Bulletin GB2," describes and illustrates the basic Dynamatic Eddy-Current units, including the new Stationary Field Coupling. If you are interested in modern speed control, write for your copy.



LIQUID COOLED BRAKES

Speed Control Problems?

One of these Dynamatic Units may be the solution

Dynamatic Eddy-Current Couplings, brakes, clutches, Dynamometers, and Ajusto-Spede motors, in use today in practically every basic industry—in both plant equipment and end products—are proving the ideal solution to difficult speed control and testing problems. Advantages include rapid response, infinitely adjustable speed control, wide speed range, quiet operation, high full-load efficiency, low maintenance cost, adjustable speed from an AC power source. Write for your copy of the new Dynamatic Bulletin GB2 today.

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DIVISION EATON MANUFACTURING COMPANY

KENOSHA, WISCONSIN • General Offices: Cleveland, Ohio

SPECIAL JOB?

Get a special Chase alloy!

TELLURIUM COPPER

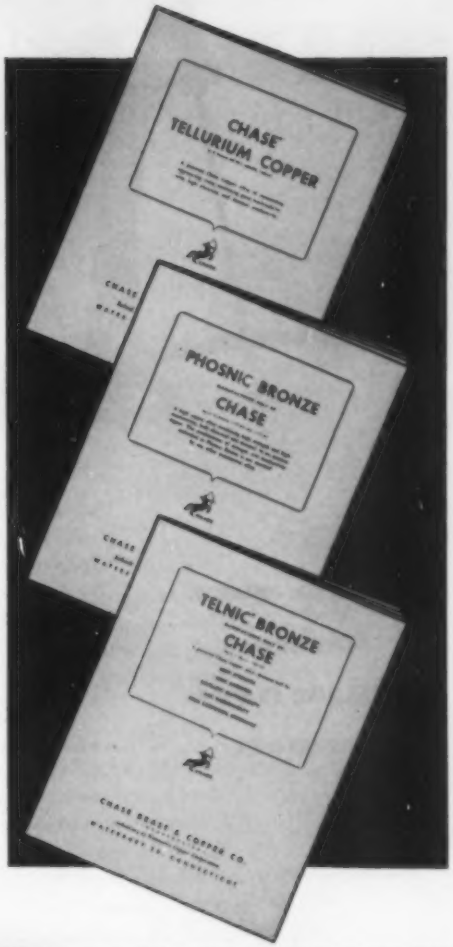
This alloy, developed by Chase, has excellent machinability *plus* high conductivity. Chase Tellurium Copper can be machined with tool speeds and settings similar to those used with Free-Cutting Brass, permitting high rates of production. But, unlike Free-Cutting Brass, Chase Tellurium Copper may be hot worked easily, and may be cold worked almost as extensively as pure copper. For Chase's free Tellurium Copper booklet, check the coupon below.

PHOSNIC® BRONZE

Chase Phosnic Bronze, an alloy made *only* by Chase, combines high strength and high conductivity to an amazing degree. This combination of high strength, high conductivity is *not matched by any other commercial alloy*. Chase Phosnic Bronze also has excellent workability, high corrosion resistance, and is available in tube, rod, and round or rolled flat wire. For Chase's free Phosnic Bronze booklet, check the coupon below.

TELNIC® BRONZE

By adding small, accurately proportioned amounts of tellurium, nickel and phosphorus to copper, Chase developed Telnic Bronze—a truly "all purpose" alloy. Chase Telnic Bronze has *excellent* machinability, hot and cold workability, high strength and conductivity, high fatigue strength and superior corrosion resistance. Chase Telnic Bronze is available in round or hexagonal rod. For Chase's free Telnic Bronze booklet, check the coupon below.



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Please send me the following Chase booklets:

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☐ PHOSNIC BRONZE ☐ TELNIC BRONZE

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Position_____
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another ROGERS innovation

"Tepee" test of paper-base laminates, with ten-inch flame applied for two minutes.

At left, standard grade continued to burn after flame was removed. It was completely destroyed. At right, flame-resistant Rogers grade extinguished itself in less than eight seconds and retained most of its structural strength.

WORK-HORSE MATERIALS MADE FLAME-RESISTANT

BY WORK-HORSE, we mean our paper-base laminates, which are now available with exceptional flame-resistant qualities. The main purpose of these materials is to reduce costs in applications that now require glass-base laminates.

We have also added flame-retardant properties to our DUROID 800, a fibrous insulating material, listed by Underwriters' Laboratories as suitable for the sole support of current carrying parts. DUROID 800 is also self-extinguishing, but will not withstand as severe burning as our flame-resistant laminates.

Since industry-wide specifications for flame-resistant or flame-retardant materials do not exist, each of these Rogers materials should be assessed in terms of your application. Complete data are available, and we will be glad to supply samples for your own testing purposes.

Please write Dept. E, Rogers Corporation, Rogers, Connecticut.

INFORMATION WITH A LIGHT TOUCH . . . Please write for "Here's Rogers Again." It will help you appraise our company's place in your plans — at seconds-per-page speed.

REINFORCED CHEMICALS

Rogers specializes in combining fibers and chemicals to produce Fiberloys that meet special material requirements. We welcome problems that existing materials can't solve.

ROGERS CORPORATION

ROGERS, CONNECTICUT

We put Hydraulic Cylinders on a reducing diet

RESULT:

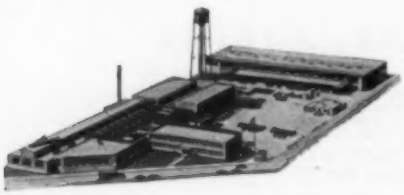
The New VICKERS® "Compact" HYDRAULIC CYLINDERS

For 2000 PSI Working Pressure

Everybody agreed that hydraulic cylinders were just too fat . . . took up too much space. So our engineers put them on a reducing diet. The result . . . these slim, powerful, "Compact" cylinders fit and work in spaces where the old type could not. It is part of Vickers long-time program of continuous improvement.

Among their many other features are: Multiple port positions. Spring-loaded synthetic-impregnated leather rod seal compensates for wear, assures long service. Piston seals are improved cup type. Tie rods are high tensile alloy steel. Adjustable integral hydraulic cushions are available. Comply with JIC standards. Conservatively rated for maximum working pressure of 2,000 psi. For further information, see Bulletin 54-68.

Waterbury Tool Division of Vickers Incorporated where "Compact" Cylinders are manufactured.



Ask for New Bulletin 54-68

VICKERS Incorporated

DIVISION OF SPERRY CORPORATION

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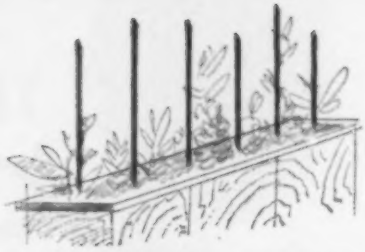
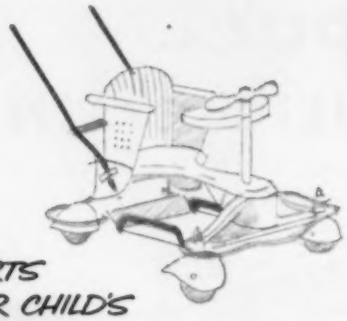
6950

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

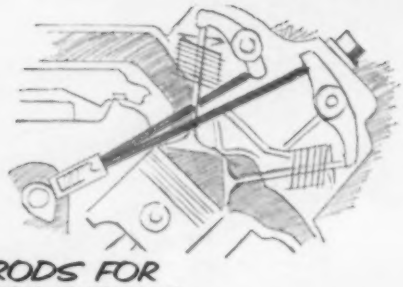
FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*



MODERN ROOM DIVIDERS



PARTS FOR CHILD'S STROLLER

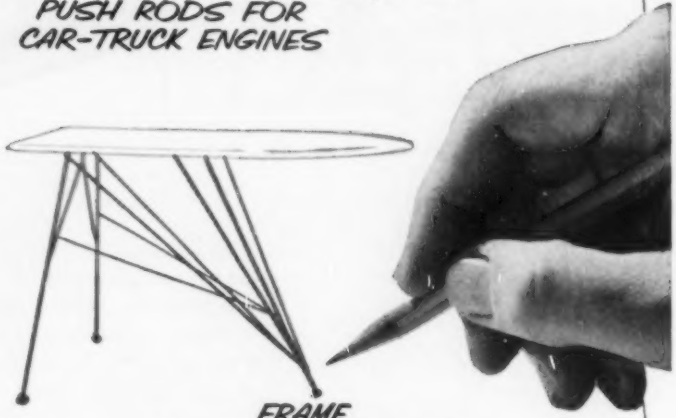


PUSH RODS FOR CAR-TRUCK ENGINES

REMARKS The success (or failure) of that new tubing application hinges largely on the tubing you specify. Why not tip the scales in your favor by using strong, lightweight Bundyweld, the only tubing double-walled from a single metal strip. Added bonuses: Bundy's expert engineering assistance, unexcelled fabrication facilities.

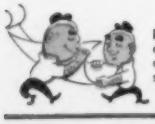
WRITE today for catalog or for help in developing your tubing idea.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



FRAME FOR IRONING BOARD

WHY BUNDYWELD IS BETTER TUBING



Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

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High thermal conductivity	Machines easily
High bursting point	Takes plastic coating
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Extra-strong	Bright and clean
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Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

Advantages of Worm Gearing

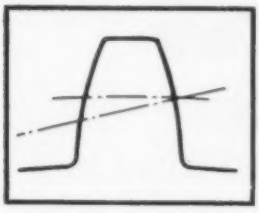
By J. E. GUTZWILLER

Assistant Chief Engineer, Worm Gearing Department

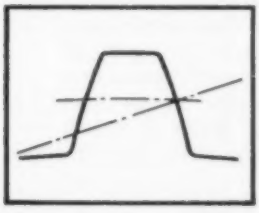
De Laval Steam Turbine Company

Interchangeability—The De Laval Steam Turbine Company was one of the first, if not the very first, manufacturer of heavy duty machinery to build worm gearing with interchangeable parts manufactured under limit gage control. Thus, worm and gear sets of like center distances but of different ratios can be readily interchanged if revision of speeds becomes necessary. Standard parts are always available for maintenance.

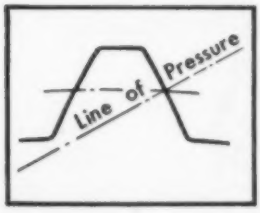
High Shock Load Capacity—The worm gear tooth form is such that the gear teeth are under a crushing, rather than a bending load. For this reason extremely high momentary and shock loads, damaging to many forms of gearing, can be successfully withstood. High momentary overloads seldom cause failure, as worm gear ratings are figured on the wear resistance of the gear teeth.



Standard 14½° involute spur gear tooth and old time worm tooth.



20° stub gear tooth.



De Laval Worm Gear Tooth. Note, line of pressure falls inside base of tooth.

Long Life—Bronze gear teeth maintain their correct form due to the regenerating action of the hardened steel worm, which retains its original shape throughout years of wear. A worm gear drive actually improves with service. This fact is peculiar to worm gearing and contributes to its recognized long life.

Smooth, Quiet Power—De Laval worm gearing transmits power by a continuous shockless action. Three or more teeth are in contact at all times, giving an even flow of torque and uniform angular velocity and eliminating vibration, pulsation, chatter and customary gear noises.

Compact Right Angle Drive—The use of worm gearing makes a neat, closely coupled, compact drive, with the motor shaft at right angles to that of the driven machine.

Larger Gear Ratios Simplify Design—Worm gearing offers larger ratios of speed reduction in a single compact set, another space-saving feature for the design engineer. The larger gear ratios obtainable in a single worm and gear set reduce the number of moving parts required.

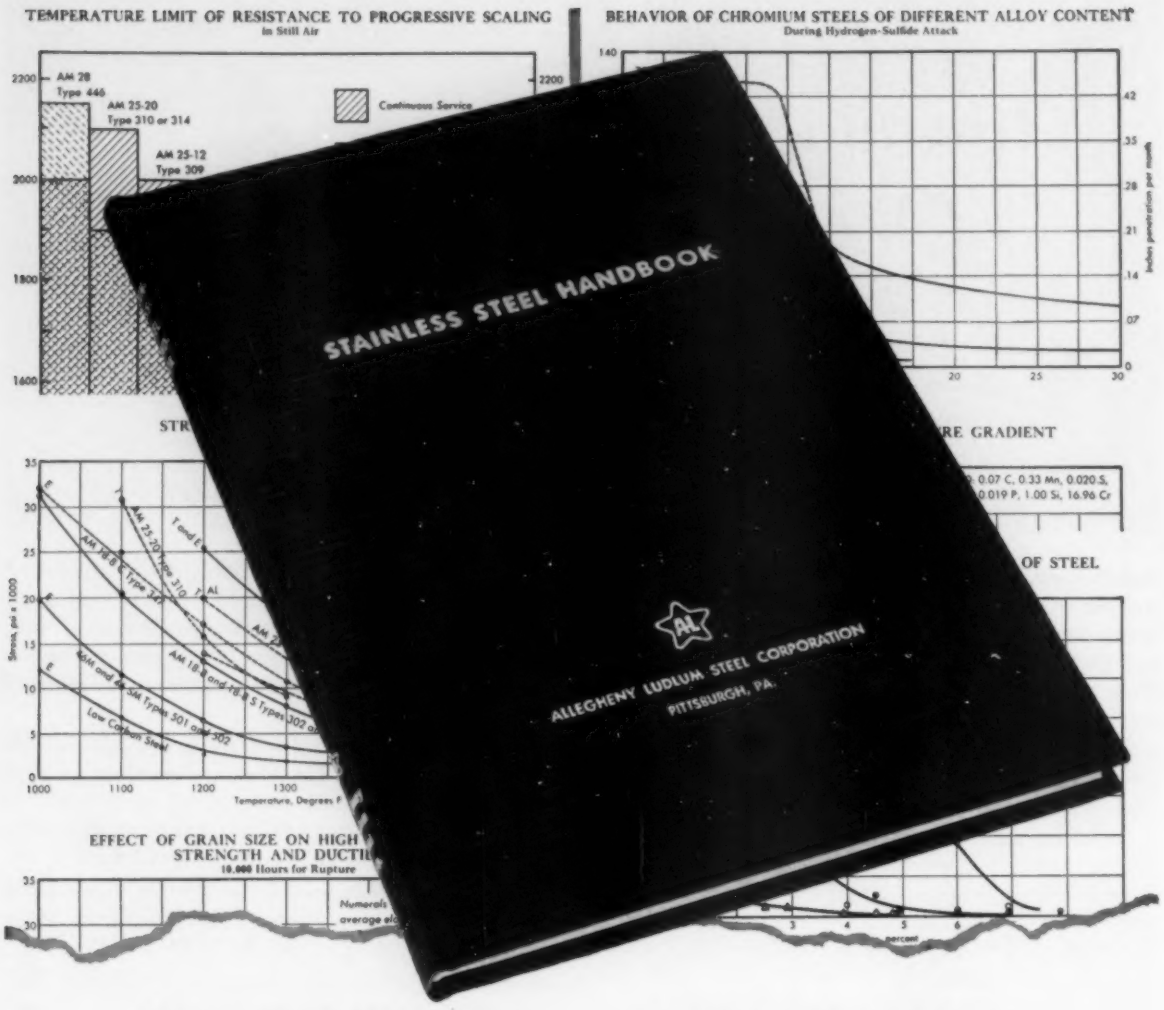
Safety and Ease of Maintenance—The small number of moving parts in a worm gear drive may be readily enclosed, thus avoiding the hazard of exposed moving parts. Assuming proper lubrication, worm gearing operates with minimum attention, even under the most adverse conditions.

Reference Manual On Worm Gear Sets

Design engineers will find this new catalog a helpful working tool in the selection of worm gear sets. It contains examples of how to select worm gearings, worm and gear data, standard worm mounting dimensions, horsepower ratings, data on shaft stresses as well as other information.

Write on your business letterhead for Catalog 5000 to De Laval Steam Turbine Company, 801 Nottingham Way, Trenton 2, New Jersey.

DL 285



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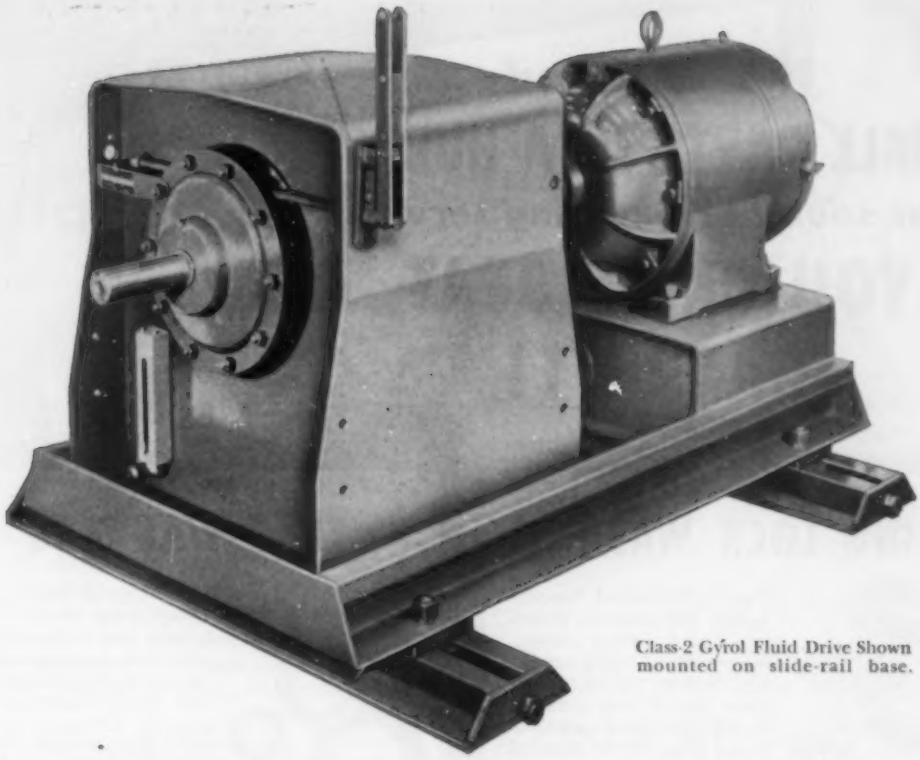

Class-2 Gyrol Fluid Drive Shown mounted on slide-rail base.

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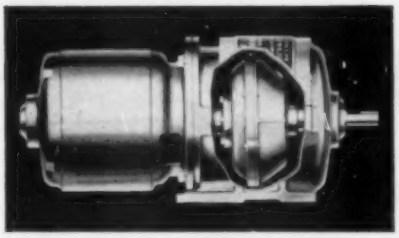

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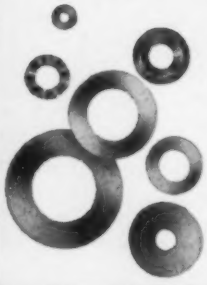

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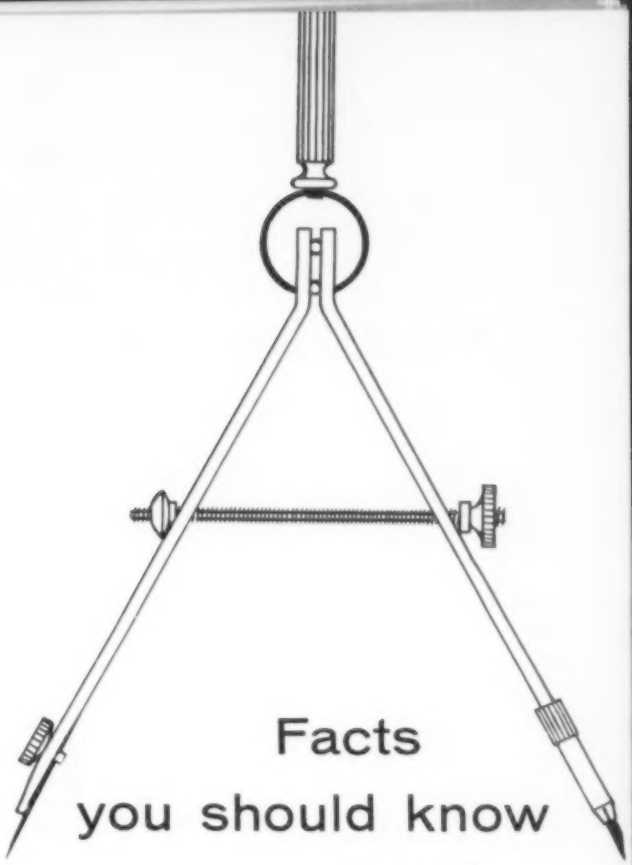


Facts you should know about Alcoa Aluminum extruded shapes

BIG EXTRUSION NEWS FOR 1954—ALCOA'S GIANT 14,000-TON PRESS MAKES POSSIBLE LARGER, THINNER, MORE INTRICATE SHAPES

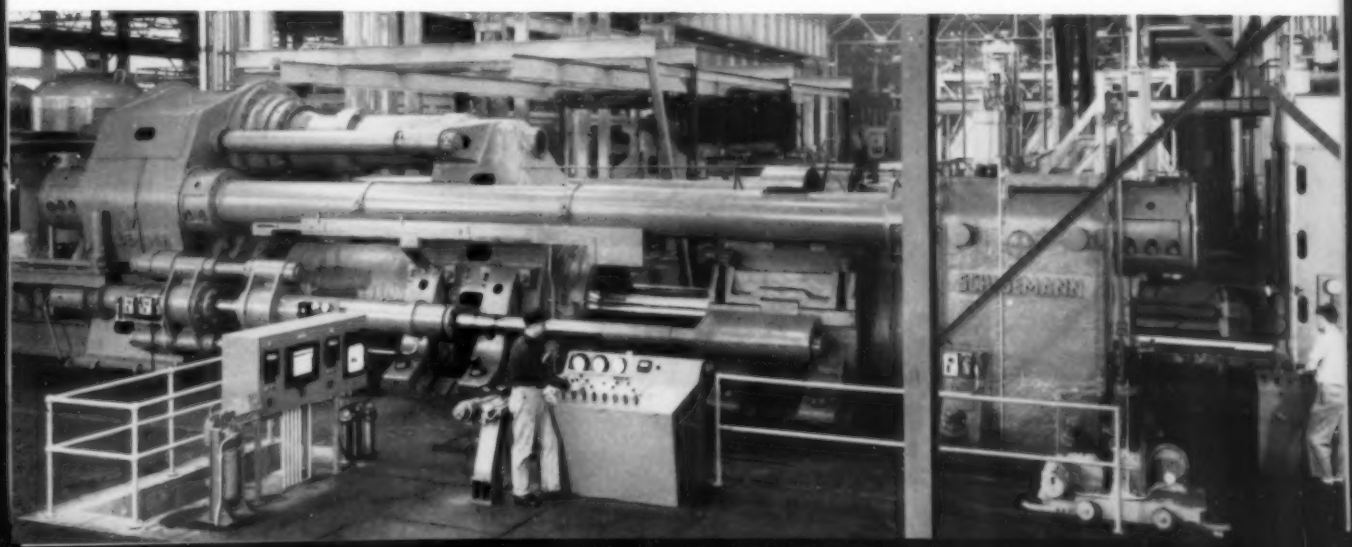
Annual production of aluminum extrusions between 1949 and 1953 increased from 150 million pounds to nearly 400 million pounds. A look at the "business end" of any one of Alcoa's fifty extrusion presses quickly shows why. A multitude of complex shapes, once requiring time-consuming assemblies, now ribbons onto the runout table in minutes. Fabrication and assembly time are reduced, product efficiency is increased and over-all costs are lowered.

Aluminum extruded shapes are used by all of industry. Biggest user last year, the building industry, consumed extruded shapes at the rate of more than 11 million pounds each month. Behind, but a close second, came the aircraft builders who, in order to increase range, speed and payload, specified between 10 million and 11 million pounds monthly. Next came truck, bus and trailer builders, who for the year built 45 million pounds of aluminum extrusions into their vehicles. Millions of pounds went into thousands of different articles varying all the way from portable outdoor clothes driers to rowboats.

But by far the biggest news in aluminum extrusions today is the installation and operation of the giant 14,000-ton press and its collateral facilities at Alcoa's Lafayette, Indiana, Works. This press, on lease from the Air Force as part of its heavy press program, offers design possibilities never available before. Until now, the largest extruded shape was one whose cross section could be encompassed in a 13-inch circle. On the new press, the practical maximum is a circumscribing circle 23 inches in diameter.

In addition to capacity for large extrusions, Alcoa has capacity for large numbers of extrusions. A total of fifty presses, the country's largest light metal extrusion facility, is readily available to you. Shapes "tailor-made" to your individual requirements can be delivered quickly and in production lots. Die charges for these "tailor-made" shapes are relatively low.

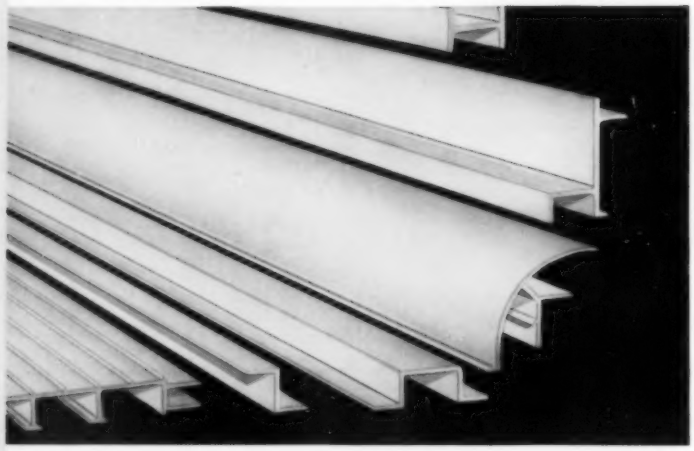
Giant, new 14,000-ton press now operating at Alcoa's Lafayette, Indiana, Works. On lease from the Air Force under its heavy-press program, this press is capable of producing far more complex, longer, wider and thinner shapes than ever before possible.



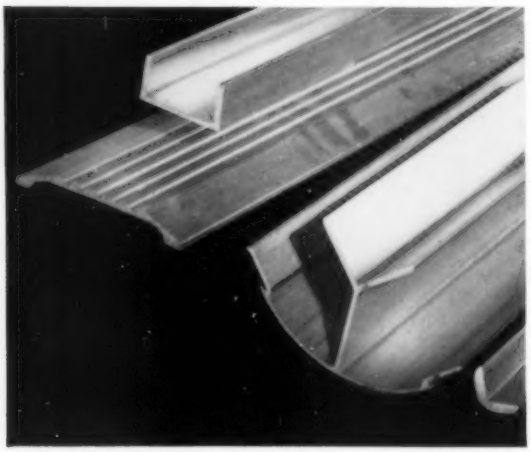
Who uses Alcoa Aluminum extruded shapes?

Almost every manufacturer has a product or part of a product which might be made more economically by extrusion. By putting the metal exactly where it's needed, by eliminating bits-and-pieces fabrication, extrusions represent an ideal solution to cost-conscious designers. Extrusions free the designer's imagination. Nearly everything he sketches can be expressed in metal by the extrusion process.

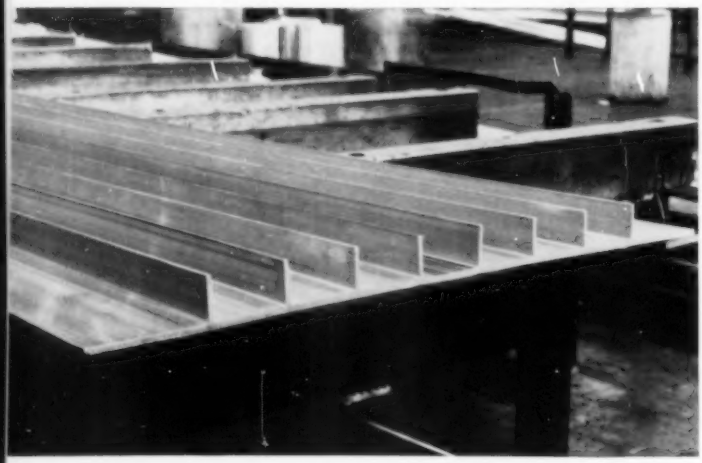
Almost anywhere you turn—at home, riding to work, flying, or in the office—you can see Alcoa® Aluminum Extruded Shapes at work . . . for you. They are there because they represented the best-known way in which certain shapes could be produced in the least time—at the least expense.



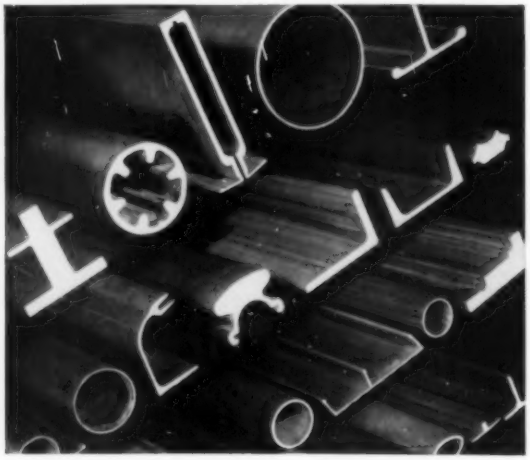
Truck body, bus and trailer builders are using more and more aluminum extruded shapes each year. Here are typical examples of shapes used for side sills, cross members, flooring, rub rails, roof bows and corner posts.



Millions of feet of aluminum extruded shapes are used every year for architectural and structural applications such as doors, windows, railings, beams, cornices and trim. Use of these shapes results in cheaper, better construction.



Aircraft designers specify aluminum extruded shapes as spars, spar caps, flooring, interior trim and, often, exterior skin sections. Exterior skin shown here is first extruded as a "V," then flattened. Strengthening rib members thus become an integral part of the outside skin.



Extrusion can be used most effectively to produce complex shapes having compound curves or undercuts. Thick and thin sections are easily joined. In short, the process provides the most efficient distribution of metal, and places that metal exactly where it is needed.

Design tips

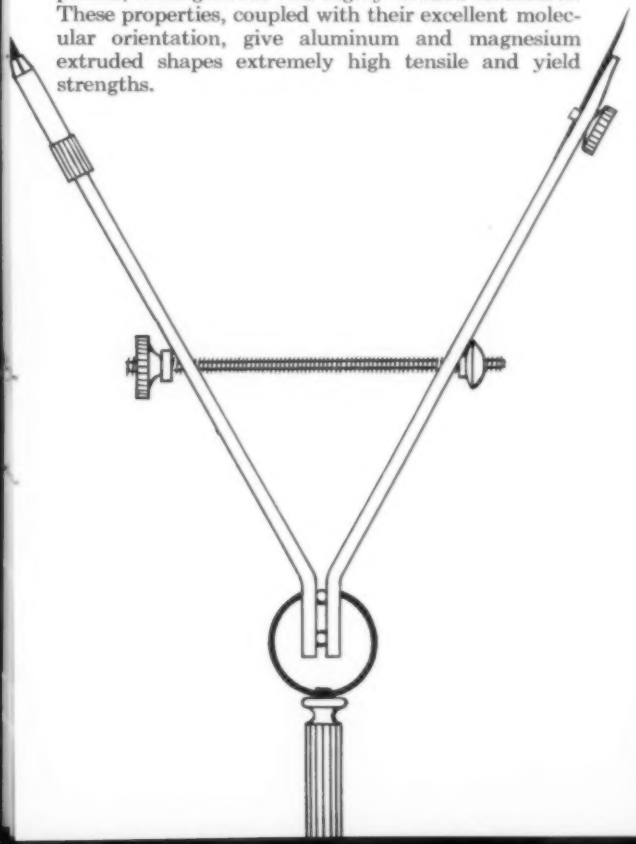
Perhaps most versatile of all the fabricating processes, extrusion permits you to reproduce in metal practically any shape you can draw—simple or complex, balanced or unbalanced, solid or hollow. Remember, however, that costs generally increase as you go from solid to semihollow to hollow.

Semihollow sections with unbalanced die tongues cause production problems. Stay away from these and extreme thickness variations or hollow shapes having unsymmetrical voids with inadequate thicknesses between voids.

Alcoa's 14,000-ton press affects fundamental design rules only in that it permits production of more intricate, wider, thinner and longer shapes.

Mechanical Properties

During extrusion, the metal is thoroughly kneaded. As a result, aluminum extruded shapes are nonporous, homogeneous and highly worked structures. These properties, coupled with their excellent molecular orientation, give aluminum and magnesium extruded shapes extremely high tensile and yield strengths.



Aluminum and Magnesium Alloy Selection

Softer alloys are generally the least costly to extrude. To keep costs down, select the softest alloy that provides the physical and mechanical properties your products require.

Most commonly extruded aluminum alloy is the heat-treatable 6063*. In the T6 temper it develops 30,000 psi yield strength, 35,000 psi tensile strength. For higher strengths, alloys* 2014, 2024 and 7075 are used.

Most widely extruded magnesium alloy is AM52S. Highest strength and elongation are achieved with AMA76S. AM3S, AM52S and AMC57S are all readily weldable by the inert gas shielded-arc method.

*Alloy Designations

New	Old	New	Old
2014	14S	6063	63S
2024	24S	7075	75S

Costs

Extrusion die costs are low, varying from $120 up. Dies for many standard shapes are kept on hand for your use at no added cost to you. Larger dies, and especially those for the 14,000-ton press, are more expensive. But because of subsequent savings in man-hours and assembly time, finished piece costs are invariably lower than for any alternate process. Moreover, the use of a standard series of die adapters often keeps tooling costs to a minimum.

Thickness

Relationship of thickness to width in extruded shapes is governed by a thickness ratio that varies with the alloy. For example, 6063 parts 8 inches wide should be no thinner than .125 inch. Over-all thickness for parts made on the smaller presses ranges from about .040 inch up to several inches with less than .040 inch produced occasionally. Typical thickness-width ratio for parts extruded from 7075-T6 alloy on the 14,000-ton press is .375 inch thick, 23 inches wide—or .156 inch thick and 34 inches wide for panel-type shapes extruded in a "V" and subsequently flattened. This is especially significant considering 7075 alloy in the T6 temper is one of the strongest of all the extrudable, heat-treatable alloys. And even this ratio is not considered to be the ultimate!

Tolerances

Extrusion, though not a precision process, can produce shapes to reasonably close tolerances. Because shapes of intricate configuration can be produced, tolerances must be measured several ways: straightness, flatness, twist, section thickness, angles and contours, and corner and fillet radii. Though it is possible to hold closer than standard tolerances in some instances, lowest cost can be maintained by specifying Alcoa standard extrusion tolerances wherever possible.

The future of Alcoa Aluminum extruded shapes

After working with extrusions for over fifty years with a total of five extrusion plants now in operation, Alcoa engineers have learned much about the extrusion process and the application of extruded shapes in cost reduction. For example, stepped shapes. Such parts as aircraft spar caps require substantially less machining. The higher pressures now available mean even better metal flow and improved molecular orientation resulting in stronger step joints.

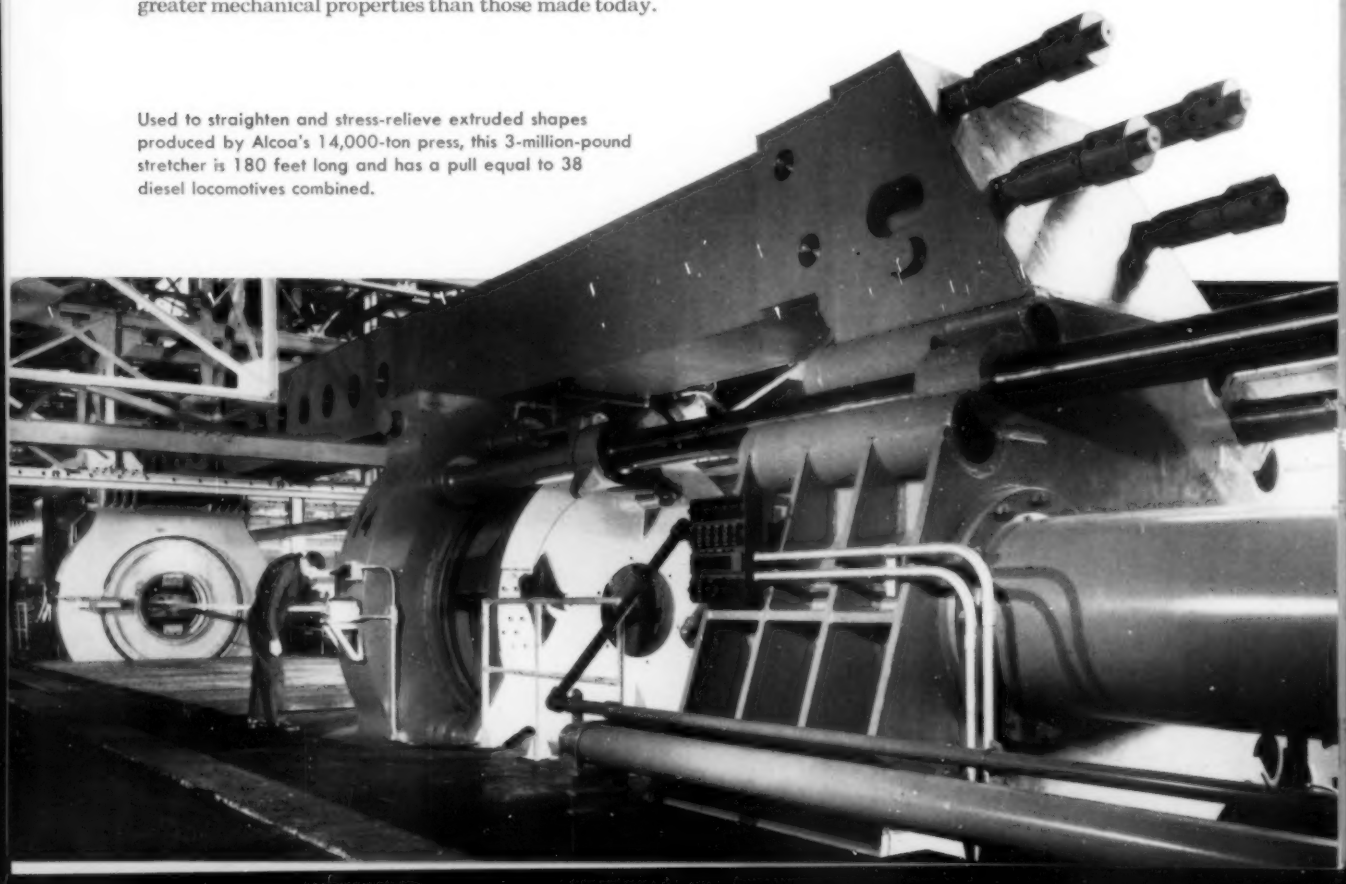
Development work is well under way on tapered wall extrusions as well. A rarity today, they may well be commonplace tomorrow. Here, as with stepped extrusions, parts will be more complete as they come from the press and the machining, now sometimes necessary, may be significantly reduced or eliminated entirely.

Extruded shapes fall into three general categories: those ready for use after being cut to length; those requiring simple machining before use; those cut into blanks for subsequent forging. Certainly higher grade forging stock will now be produced. Moreover, techniques are being perfected which will permit effective combination of the forging and extrusion processes to produce shapes far more complex and possessing far greater mechanical properties than those made today.

Your next step

Write ALUMINUM COMPANY OF AMERICA, 1992-K Alcoa Building, Pittsburgh 19, Pa., for your free copy of our book, *Alcoa Aluminum Extruded Shapes*. Use your company letterhead and be sure to let us know your job function.

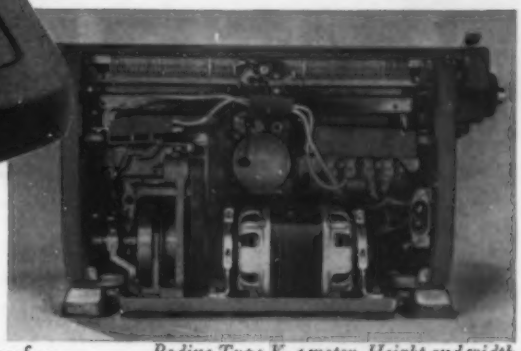
Or, if you have some specific design problem now, contact your local Alcoa sales engineer. Don't hesitate to use his time and talents freely, even if you are not planning to use extruded shapes next week, next month or next year. You can locate his office by looking under "Aluminum" in the classified section of your telephone directory.



Used to straighten and stress-relieve extruded shapes produced by Alcoa's 14,000-ton press, this 3-million-pound stretcher is 180 feet long and has a pull equal to 38 diesel locomotives combined.

does your motor measure up to...

your product?



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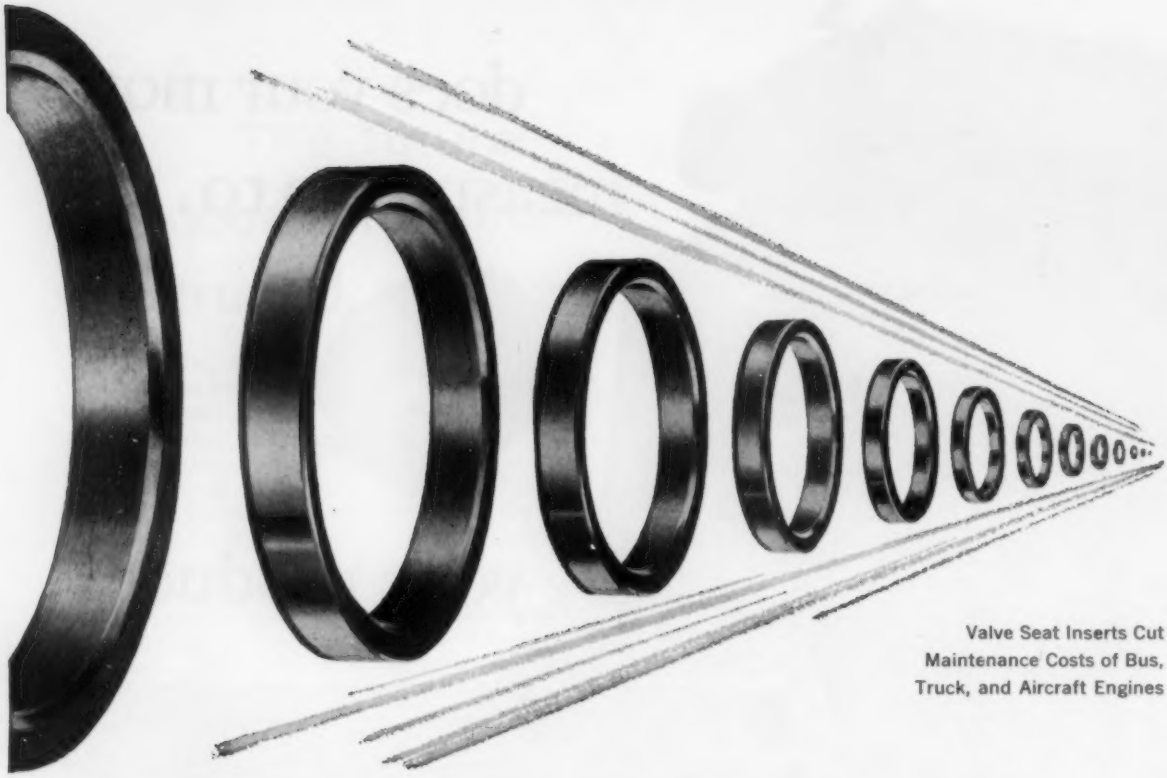

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Valve seat inserts made from HAYNES STELLITE alloy have given as much as 200,000 miles of service in truck engines before regrinding was required. These inserts stand up under continuous impact without cracking. They won't stretch or distort even under abnormal operating temperatures, and will retain their hardness even at high temperatures.

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The wear, corrosion, and oxidation-resistant qualities of HAYNES STELLITE alloy valve seat inserts further insure peak performance at low maintenance costs. These cobalt-base parts resist the erosive effects of hot exhaust gases. They are practically unaffected by corrosives present in the fuel, and will not pound in at high operating temperatures.

AVAILABLE IN A VARIETY OF SIZES

The inserts can be supplied in a variety of sizes for use in bus, truck, aircraft, marine, and other types of internal combustion engines. The unusual properties of HAYNES STELLITE alloy make it possible to produce efficient inserts as thin as $\frac{5}{32}$-in. in cross-section. Use of these thin inserts enables the engine designer to locate water jackets closer to actual valve seating surfaces, and provide a more effective cooling system.

For full information on sizes, and prices, write to Haynes Stellite Company, 725 South Lindsay Street, Kokomo, Indiana.

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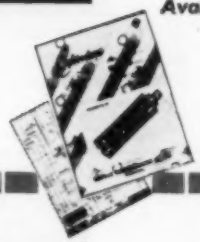

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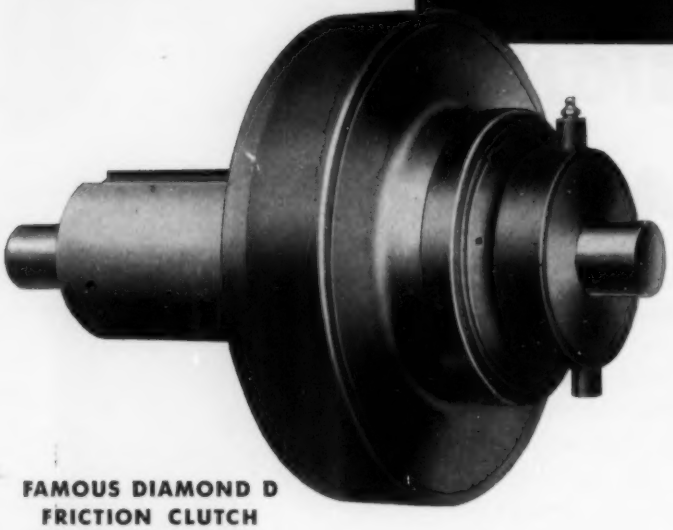


FAMOUS DIAMOND D
FRICTION CLUTCH
CAPACITIES UP TO
470 H.P.!

Look to Dodge for the clutches to meet your specific needs. Dodge leadership in the field of mechanical power transmission is strikingly evidenced in the advanced design and engineering of a complete line of friction clutches, in a full range of sizes with capacities from 1/3 hp to 470 hp.

ROLLING GRIP FRICTION CLUTCH

New and simplified design gives new ease of control with positive drive and extreme ruggedness. There are no toggles! Instead the mechanism shifts smoothly on hardened steel balls—and has the positive grip of a wedge. (Operating parts enclosed for safety yet quickly accessible for service). Available from distributors' stocks in two types—Bolted Plate or Gear Tooth Mechanism in sizes from 1/3 hp to 21 hp at 100 rpm.

DIAMOND D FRICTION CLUTCH

Built with the stamina for grueling service, this rugged clutch has a world-wide reputation for dependability. It's compact, too—completely enclosed in both engaged and disengaged positions. Adjustment is simple—an Allen wrench at one point does the job. Available in single, double or triple friction plate design in several types of construction. Capacities from 21 hp to 470 hp at 100 rpm.

DODGE MANUFACTURING CORPORATION
1200 Union Street, Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new cost-saving methods. Look for his name under "Power Transmission Equipment" in your classified phone book.

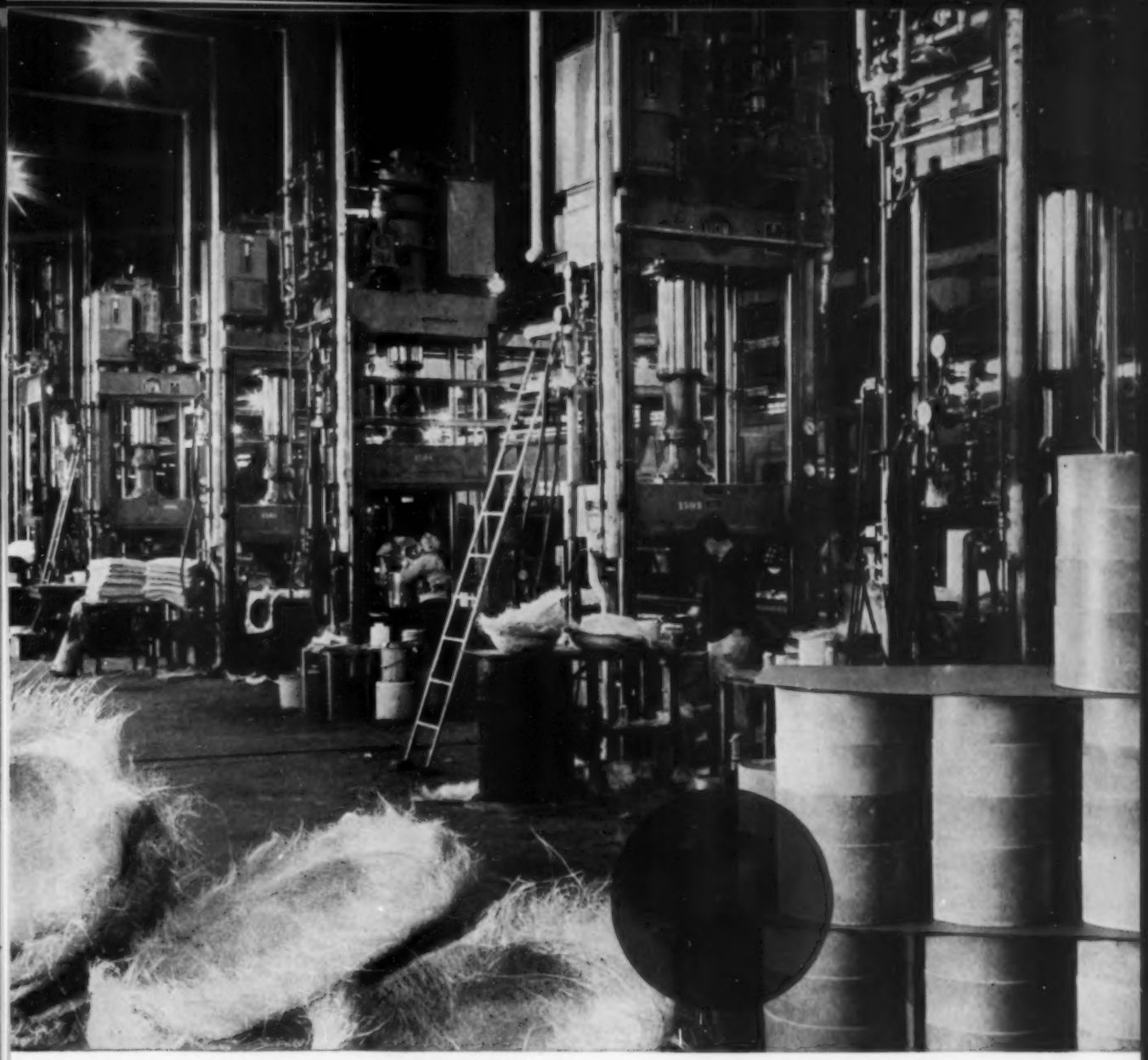
SEALED-LIFE V-BELTS AND TAPER-LOCK SHEAVES

TORQUE-ARM SPEED REDUCER

DODGE-TIMKEN PILLOW BLOCKS

NAME PLATES

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY,
CHICAGO THRIFT-ETCHING CORPORATION, 1555 SHEFFIELD AVENUE, CHICAGO 22, ILLINOIS



need strength in your product? use plastics molded by General American

What kind of a strength would you like in your product? *Shock resistance*, like a survivors' kit that withstands parachute drops in rough terrain? *Structural strength*, like a TV cabinet? *Stamina*, for working parts, like a washing machine agitator? *All-weather toughness*, like a street light globe? General American has molded all these and more.

General American's molding facilities can often give your product strength in plastics that will outlast and out-perform conventional materials . . . plus new lightness, beautiful color and big volume production. Ask a General American engineer for ideas to help you.

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GENERAL AMERICAN TRANSPORTATION CORPORATION 135 South La Salle Street, Chicago 90, Illinois

●Facilities unmatched anywhere: injection presses to 300 ounces, compression presses to 2,000 tons, reinforced plastics molding, die making, painting, assembly, packaging

Make your own comparison of the

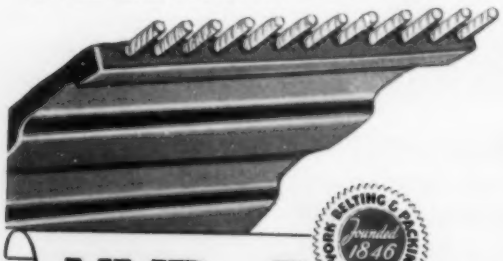
Gilmer THE ORIGINAL "TIMING" BELT DRIVE

versus other forms of Power Transmission

	GILMER "TIMING" BELT DRIVE	FLAT BELTS	CHAIN	V BELTS	GEARS
1. Can it transmit 1/100 to 300 HP without slippage . . . and without lubrication?	Yes				
2. Does it eliminate noise and vibration caused by metal-to-metal contact?	Yes				
3. Does it operate at maximum efficiency, indefinitely, without take-up?	Yes				
4. Does it make possible very compact, short-center drives of ratios up to 15-to-1?	Yes				
5. Does it eliminate need for initial tension, permitting all the drive's tension to be used effectively . . . and reducing bearing wear?	Yes				
6. Can it operate satisfactorily at peripheral speeds above 12,000 FPM?	Yes				
7. Does it maintain constant angular velocity?	Yes				
8. Is its weight very low in proportion to its strength?	Yes				
9. Does it make possible precise "timing", without appreciable backlash, between two or more widely separated shafts?	Yes				
10. Does it eliminate the expense and added weight of lubricants, lubricating devices and covers?	Yes				
11. Does it save so much power as to sometimes permit use of lower-powered motors?	Yes				
12. Does it have unusually long, maintenance-free service life?	Yes				

WHEN PLANNING A DRIVE, CONSIDER ALL FIVE!

NEOPRENE-ENCASED, CABLED STEEL WIRE GIVES THE BELT GREAT STRENGTH WITHOUT BULK



Naturally, these questions are phrased to emphasize the unique *combinations* of features provided by the "Timing" Belt drive. Question 1, for example, might have been divided into two separate questions. But this would not point up the important fact that the "Timing" Belt drive is the *only positive drive requiring no lubrication.*

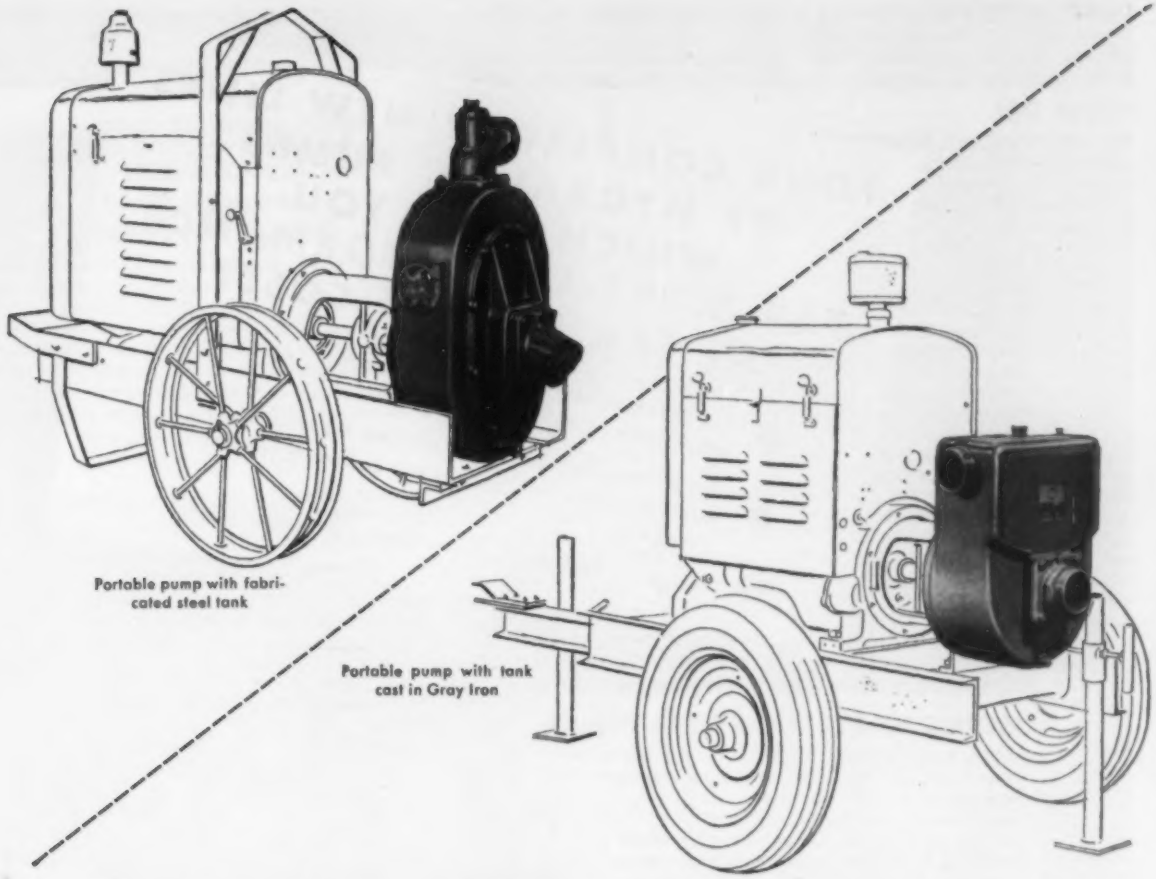
Certainly, the four older types of drives will always have their special places in the power transmission picture. The important fact is that the design engineer now has at his disposal a *fifth* type of drive ideally suited to so many applications that more than a million are now in use.

Write for your copy of the Gilmer "Timing" Belt Stock Drives Manual, to Gilmer "Timing" Belt Division at the address below.

NYB&P — NEW YORK BELTING & PACKING CO. Founded 1846

NEW YORK BELTING & PACKING CO. 1 Market St., Passaic, N. J.

America's Oldest Manufacturer of Industrial Rubber Products



Portable pump with fabricated steel tank

Portable pump with tank cast in Gray Iron

Costs down 20%... efficiency up with GRAY IRON!

This Marlow portable self-priming centrifugal pump originally was made with a fabricated steel pump tank. In modernizing the unit the manufacturer redesigned the tank for production in Gray Iron, thus realizing a *20% saving in costs* . . . as well as substantially increased efficiency over the fabricated tank previously used.

This same type of cost-saving story may be told about some of your fabricated parts, if you take the time to consider the many advantages of the Gray Iron casting process. Write for technical information.

GRAY IRON CHARACTERISTICS INCLUDE:

CASTABILITY
STRENGTH
RIGIDITY
LOW NOTCH SENSITIVITY
WEAR RESISTANCE
HEAT RESISTANCE
CORROSION RESISTANCE
DURABILITY
VIBRATION ABSORPTION
MACHINABILITY

MAKE IT *BETTER*...WITH GRAY IRON

75% of all cast metal products are Gray Iron

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

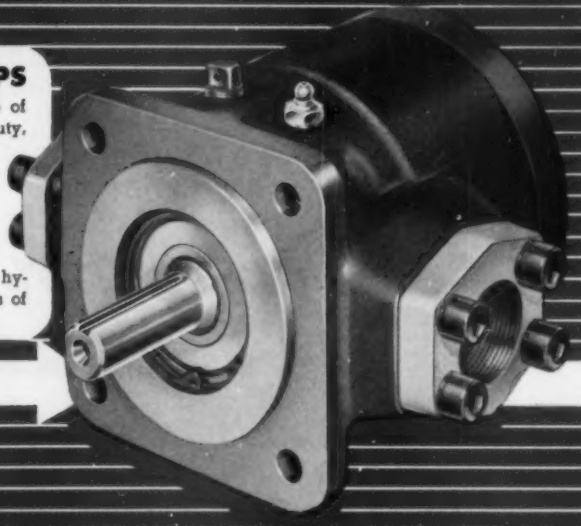
5000 PSI

FOUR COMPLETELY NEW LINES OF HYDRAULIC PUMPS WHICH GIVE YOU FAR MORE IN PERFORMANCE AT FAR LESS IN COST!

- Pumps to give new life to existing equipment . . . to improve performance, increase capacity!
- Pumps that afford the design engineer the basic equipment for entirely new concepts in hydraulically operated machines!
- Pumps for machines to do work better, quicker, cheaper!

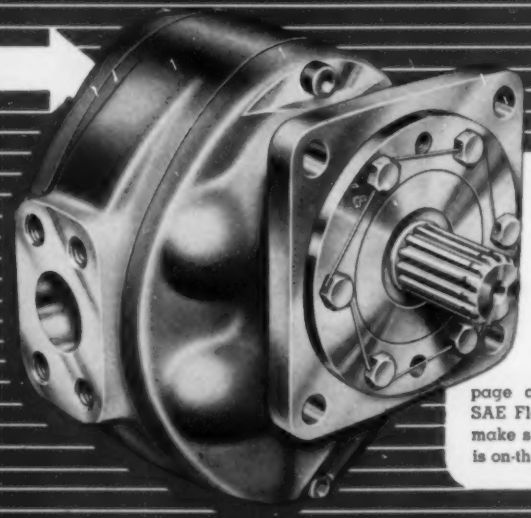
SERIES PF-100 VANE-TYPE PUMPS

DUDCO PF-100 Series Pumps can double the value of your *hydraulic dollar*. You get 2000 psi continuous duty, single-stage construction for the cost of equal capacity low pressure pumps . . . improved equipment design and increased machine efficiency without the payment of premium prices. These Pumps feature a simplified, 3-unit construction . . . the pumping cartridge incorporates the famous DUAL-VANE design which provides and assures complete balance of all hydraulic pressure loads. These Pumps have capacities of 3, 5, 8 and 11 gpm at 1200 rpm.



2000 PSI

1500 PSI

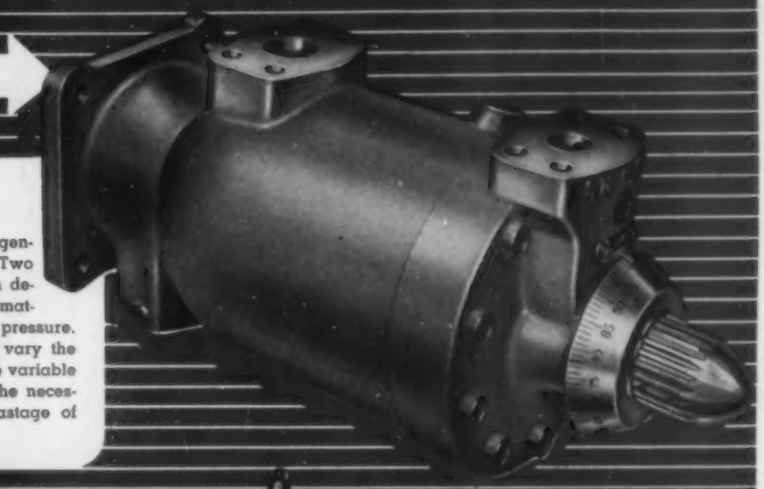


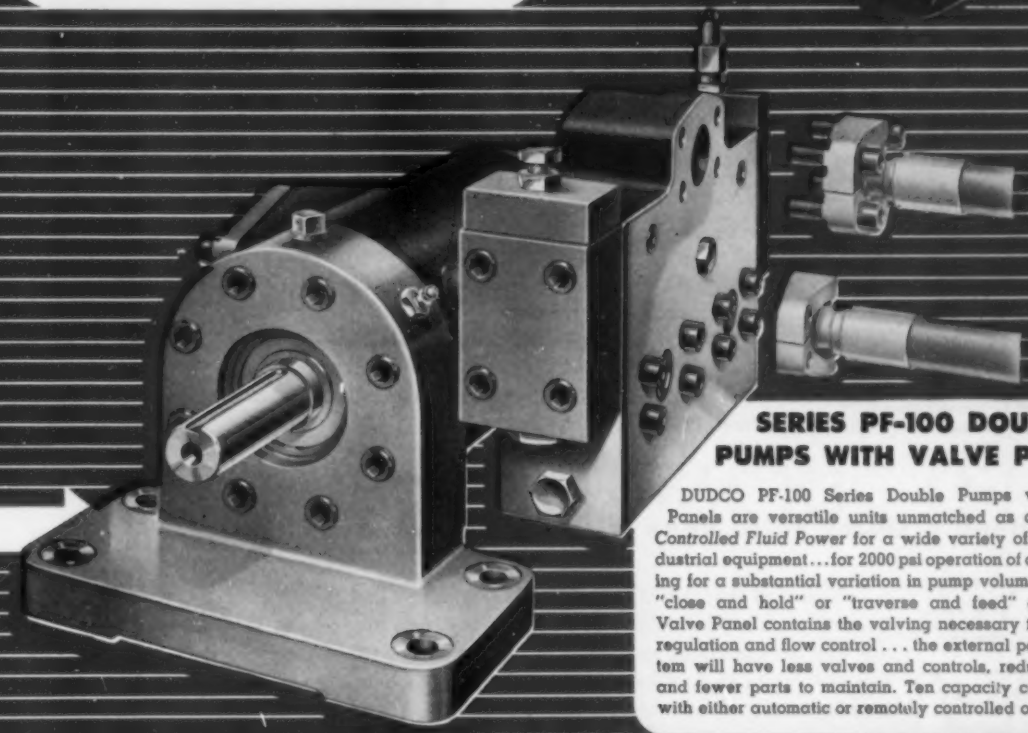
SERIES H GEAR-TYPE PUMPS

The HYDRECO Series H Pumps are intended for use in the hydraulic systems of heavy-duty mobile and industrial equipment, especially where shock loads, impact and rugged service are "normal working conditions". Four sizes (40, 50, 60, 70 gpm) deliver fluid power at 1500 psi . . . increased horsepower gives greater work output. *Pressure-Balanced* wear plates reduce oil slippage and eliminate power-robbing frictional contacts. SAE Flange Mounting and split-flange hose connections make servicing simple and reduce down-time. Equipment is on-the-job longer.

SERIES PV-600 PISTON-TYPE PUMPS

DUDCO PV-600 Series Variable Delivery Pumps generate continuous duty pressures up to 5000 psi. Two types of controls match pump output to system demands. A pressure-compensated regulator automatically varies the volume in response to system pressure. A hand wheel control enables an operator to vary the volume during the machine cycle. High pressure variable delivery means power is transmitted without the necessity for an accumulator and without any wastage of power thru a relief valve.





SERIES PF-100 DOUBLE PUMPS WITH VALVE PANELS

DUDCO PF-100 Series Double Pumps with Valve Panels are versatile units unmatched as a source of *Controlled Fluid Power* for a wide variety of modern industrial equipment... for 2000 psi operation of circuits calling for a substantial variation in pump volume as during "close and hold" or "traverse and feed" cycles. The Valve Panel contains the valving necessary for pressure regulation and flow control . . . the external part of a system will have less valves and controls, reduced piping and fewer parts to maintain. Ten capacity combinations with either automatic or remotely controlled operation.

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The New York Air Brake Company
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Please send details on

- ☐ SERIES PF-100 VANE-TYPE PUMPS
- ☐ SERIES H GEAR-TYPE PUMPS
- ☐ SERIES PF-100 DOUBLE PUMPS WITH VALUE PANELS
- ☐ SERIES PV-600 PISTON-TYPE PUMPS

Name_____

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City_____ Zone_____ State_____

This simple idea saves money in V-Belt Costs

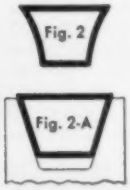
You can prove it in two minutes!

To prove how the CONCAVE SIDES of GATES VULCO ROPES *save money,* just make this simple test—

Bend *any* V-Belt that has *straight sides* (Fig. 1) and—as the belt bends—*feel* the sides *bulge out* (Fig. 1-A). This out-bulge concentrates the wear at the points shown by arrows—and this naturally shortens the life of a *straight-sided* belt!

Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2)

(U. S. PAT. 1813698)



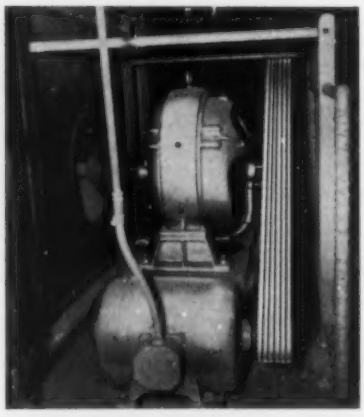
You find that the CONCAVE SIDES *fill out* and become perfectly straight. They thus press *evenly* against the V-pulley. All wear is distributed *uniformly* across the *full width* of the GATES VULCO ROPE—and this means *longer* belt *life* and *lower* belt *cost* for you!

When you buy V-Belts, be sure to get the V-Belt with the CONCAVE SIDES—the GATES VULCO ROPE!

VULCO ROPE DRIVES

THE GATES RUBBER COMPANY
DENVER, U.S.A.

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.



Typical Gates Vulco Rope Drive—the Gates V-Belts are built with Concave Sides to insure longer belt wear.

CS-545

For *positive* bearing protection on Military Jeeps-

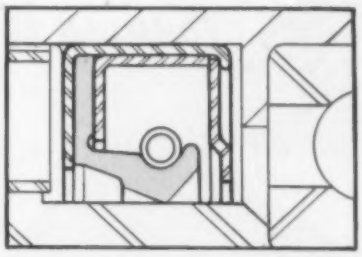
Every Willys Military Jeep has a "transfer case" which provides for 2 functions: (1) Engaging the front axle drive; (2) Engaging the emergency low gear ratio. Spicer uses dependable Garlock KLOZURES to protect the front and rear bearings on the output shaft of this important mechanism.

Spicer uses KLOZURE* Oil Seals

The Spicer "transfer case" in a Military Jeep must be able to function smoothly under the most adverse operating conditions. Thus, the bearings on the output shaft (which operates at speeds up to 4,000 R.P.M.) need *positive* protection against dust, mud, and water; the bearing lubricant must be sealed in. This job calls for a superior oil seal. Spicer engineers rely on KLOZURE garter-spring Model 65.

Take a tip from Spicer, who for 50 years has been manufacturing precision parts for the automotive industry. Standardize on KLOZURE Oil Seals—the best bearing protection money can buy.

There's a service-tested KLOZURE model for every bearing application. For complete information contact your Garlock representative or write for KLOZURE Catalog No. 10.



Installation of Model 65 KLOZURE Oil Seal on the output shaft bearing of the Spicer "transfer case."

*Registered Trademark

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

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GARLOCK

PACKINGS, GASKETS, OIL SEALS
MECHANICAL SEALS
RUBBER EXPANSION JOINTS

It pays to know the difference

The hex socket identifies all socket screws, but beyond the hex there's a big difference. If you think all makes are alike — if you have never tried P-K Socket Screws — you are blocking your way to *proved* benefits that other buyers are using to advantage.

Look *beyond* the hex. For example, until you see P-K product information for the first time, you'll have no idea how much more helpful it is . . . how much time it saves . . . how much easier it makes the job.

Look Beyond the Hex

Compare every detail of product and service. You'll find P-K Socket Screws take top rating by every test.

For cost-wise assembly, you need all these advantages. Why miss out on any of them? Try P-K Socket Screws. Get samples, information from your P-K Distributor or write. Parker-Kalon Division, General American Transportation Corporation, 200 Varick Street, New York 14.

for Planning Aids patterned to your special needs

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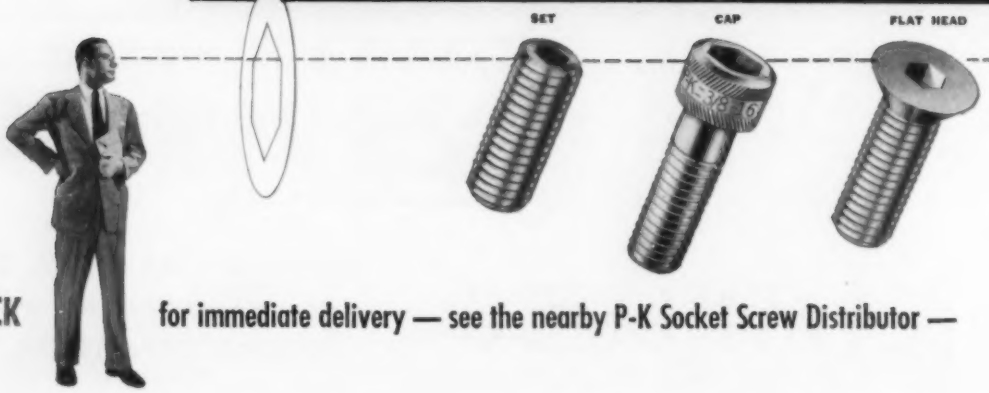
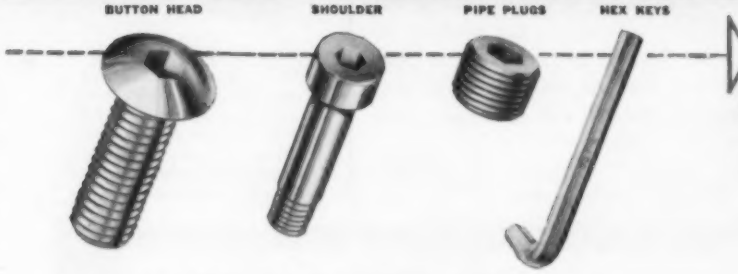


IN STOCK for immediate delivery — see the nearby P-K Socket Screw Distributor —

SOCKET SCREWS

BUTTON HEAD | SHOULDER | PIPE PLUGS | HEX KEYS



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P-K ENGINEERING DATA

is prepared to meet the special needs of design, project, and methods engineers, to give anyone concerned with planning assemblies complete, clear, concise information. The popular P-K Socket Screw Dimension Finder is a pocket size plastic slide chart that gives all needed dimensions at a glance.

P-K PRICE DATA

wins praise from purchasers because it is easier to use, speeds ordering, prevents errors.

FOR ADVANCED DESIGN that speeds assemblies — makes them simpler, stronger — and saves errors.

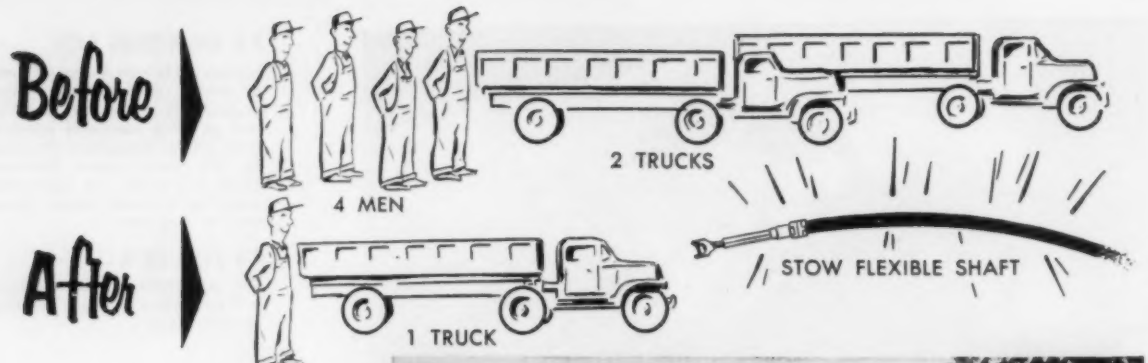
FOR TOP QUALITY and tolerance gaged to your most exacting specifications — and guaranteed.

FOR ASSEMBLY STRENGTH okayed in a million punishing tests by thousands of satisfied users.

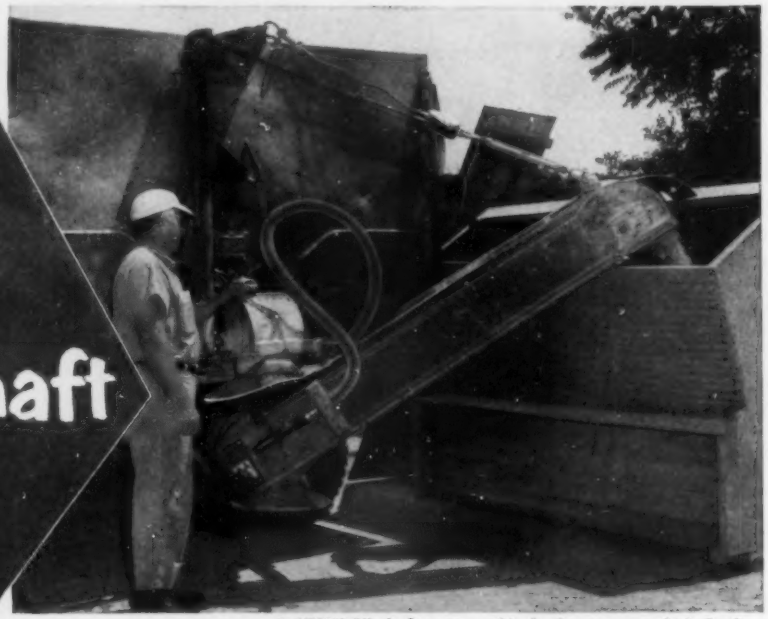
FOR SUPPLY SERVICE set up for fast action and lower purchasing expense — by local Distributors.

FOR ANY STYLE OR SIZE You'll find any Socket Screw you need in P-K's complete line. Hex Keys in all sizes, and several handy sets.

GET **ALL**
THESE ESSENTIALS OF
COST-WISE ASSEMBLY
GET **P-K**



A STOW flexible shaft makes the difference



A STOW 1" shaft powers this feed conveyor which feeds 200,000 ducks on a Long Island Duck Farm each day. Formerly 4 men, 2 trucks were required to do the job.

Again ingenuity and a STOW flexible shaft pay off!

Talk about efficiency...
One man, one truck and one STOW flexible shaft now do the job that formerly required 4 men and two trucks—*and in half the time!*

Yes, a STOW flexible shaft *makes the difference.* Perhaps you can use STOW flexible shafting to advantage in some of the power transmission problems you are working on right now. STOW engineers are at your disposal. Check on the advantages of flexible shafting in connection with your next power transmission problem.

Flexible shafting since 1875

Write today for FREE Engineering aids. This handy torque calculator and Bulletin 525 titled Engineering Data are yours for the asking. Write today on your company letterhead.

STOW

STOW MANUFACTURING CO.
426 State Street, Binghamton, N. Y.

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FEDERAL-MOGUL CORPORATION • 11043 Shoemaker • DETROIT 13, MICH.

Sleeve bearings in many designs and sizes; cast bronze bushings; bimetal rolled bushings; rolled split bushings; washers, spacer tubes, precision bronze parts and bronze bars.

FEDERAL Mogul
since 1899

FEDERAL-MOGUL

YOU CAN'T BUY A BETTER PUMP FOR HEAVY DUTY POWER STEERING

PESCO Pressure-Loaded
Model 052817 Hydraulic
Steering Pump

If you are interested in "man-sized" power for your heavy duty power-steering systems without excess bulk or weight, you'll want to test the Pesco Power-steering Pump on your specific equipment.

This outstanding Pesco pump is specifically designed and ruggedly constructed to provide full, dependable power steering for on-and-off-the-road heavy duty vehicles. It is not an adaptation of a standard passenger car unit applied to heavy duty use. The unit provides a standard pressure relief setting of 750 psi, with optional pressures to 1200 psi if desired.

A limited number of these exceptional Pesco pumps are available for field tests on specific equipment. For full information call or write the Home Office, Bedford, Ohio.

For full information on Pesco Hydraulic Pumps, Power Packages, Hydraulic Motors, Electric Motors, or Controls and Valves, call or write the Home Office, Bedford, Ohio.

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PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 7 — 1954

New Broadway Tunnel in San Francisco Features Glare-Proof Lighting Fixtures of Du Pont "Lucite"

Lighting engineers, by using clear Du Pont "Lucite", have been able to design efficient, safe, and uniform lighting for San Francisco's modern Broadway Tunnel. Fixtures manufactured by Sunbeam Lighting Company, Los Angeles, California.

Light-diffusing qualities of "Lucite" enhance safety in 1616 foot tunnel

SAN FRANCISCO'S $7,000,000 Broadway Tunnel under the Russian Hill has received many prizes for its ultramodern lighting system. This system was scientifically planned and developed for maximum safety and efficiency.

And playing an important role in this system are clear, sparkling lighting fixtures of Du Pont "Lucite" acrylic resin. The designers decided to use lighting fixtures of extruded "Lucite" along the 1616 feet because special advantages were inherent in this Du Pont engineering material. The fixture panels are ribbed on the inside to insure an even distribution of light. There is controlled light intensity at the tunnel's entrances and exits to ease eyestrain and reduce danger of accident.

Strong and Durable

The extruded fixtures of "Lucite" are smooth on the outside—can be kept sparkling clean. Shatter-resistant "Lucite" easily withstands the high velocity jet streams of water-detergent used in the cleaning operation. "Lucite" has exceptional durability. It resists weathering and crazing—is not affected by fumes or other corrosive substances.

Other Applications

Tough, lightweight Du Pont "Lucite" has many applications in the lighting industry. Its excellent light-transmitting and edge-lighting properties contribute to the wide use of "Lucite" for signs, displays, and other decorative appliances. It can be worked with simple tools and techniques . . . is readily molded into convenient shapes by injection molding, compression molding, extrusion, and vacuum forming.

Have you evaluated Du Pont "Lucite" in terms of your engineering requirements? We will gladly send you complete information on the properties and uses of this unique engineering material. Fill out the coupon on the next page and mail it today.

OVER

Flexible seal cages of Du Pont "Teflon" snap on easily, won't score shaft or sleeve

SEAL CAGES of Du Pont "Teflon" tetrafluoroethylene resin used on pumps offer advantages available with no other engineering material. They are flexible and molded in one piece—can be snapped on and off the shaft quickly and easily.

"Teflon" is widely used today in the process industry. It combines high heat resistance and low temperature toughness. It has a low coefficient of friction, and is chemically inert to all corrosives except molten alkali metals and fluorine at elevated temperatures and pressures.

Seal cages of "Teflon" will not score if they contact the shaft or sleeve when pump is in operation. And they will not bend or collapse under extreme gland pressure.

The manufacturer reports not a single case of failure with these seal cages of "Teflon" after five years of service in fatty acids.

Tough, flexible, chemically inert seal cages of Du Pont "Teflon". These are manufactured by Chemical and Power Products, Inc., of New York City.

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Better Things for Better Living through Chemistry

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 7 — 1954

"Alathon" puts new utility in lunch box

HERE'S SOMETHING new in the modern lunch box—a tough, corrosion-resistant box of "Alathon" polyethylene resin. This lunch box will take hard knocks without denting or chipping. Food is not affected by "Alathon" because it is tasteless, odorless, and non-toxic. Top, bottom, integral hinges, clasps, and handle are produced by economical injection molding. Manufactured by Dapol Plastics, Inc., Worcester, Mass.

Investigate Du Pont engineering materials in your product development programs

ONE OF the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"** nylon resin are helping solve industrial design problems.

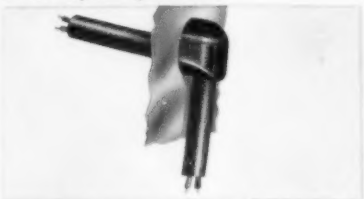
NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

Strain relief bushings of tough "Zytel" lower production costs

STRONG, DURABLE Du Pont "Zytel" nylon resin is used for strain relief bushings, eliminating need for grommets or wire knots. These bushings anchor the cord to the chassis of electrical appliances in a non-slip insulating grip. They absorb pull, push, and torque and have excellent impact strength. These bushings of "Zytel" are produced by the Heyman Manufacturing Co., of Kenilworth, New Jersey.

Regular-type strain relief bushing of resilient "Zytel" nylon resin.

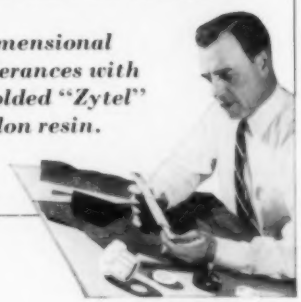


Right-angle strain relief bushing exits power supply cord parallel to the chassis to conserve space.

This is a spring-type strain relief bushing. "Zytel" affords close joining, presents neat, trim appearance.

POINTERS ON PROCESSING

Dimensional tolerances with molded "Zytel" nylon resin.



EXPERIENCE SHOWS that tolerances obtainable with "Zytel" by injection molding techniques compare very favorably with those of equivalent machined metal parts intended for interchangeable use in assemblies, and are superior to those obtainable with cast or sintered metal. Although temperature and humidity affect "Zytel" to a greater degree than metal, experience at Du Pont Sales Service Laboratory indicates that tolerances of ± 0.001 to $\pm 0.002''$ per inch can be achieved and maintained under operating conditions normally encountered. (Specific tolerance control suggestions in the injection molding of "Zytel" are given in Polychemicals Department Information Bulletin No. X-38a.)

New weather-resistant "Zytel" 105 nylon resin for outdoor use now available

THIS BLACK "Zytel" 105 nylon resin is a tough material with excellent outdoor weatherability. Results of accelerated weathering tests and exposure, in Florida, indicate that excellent outdoor life can be expected. Toughness, abrasion-resistance, and form stability at high temperatures are combined with lightness of weight to make "Zytel" 105 ideal for many outdoor applications. In the agricultural field, "Zytel" 105 is suitable for such components as gears, sprockets, and seeding plates. Used for hub caps and air brake line connectors, this new material offers new design techniques to the automotive industry. In the electrical field, low voltage terminal boxes and instrument covers are just a few of the many possible applications.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 1010, Du Pont Building, Wilmington 98, Delaware.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel"*; ☐ *"Alathon"*; ☐ *"Teflon"*; ☐ *"Lucite". I am interested in evaluating these materials for:* _____

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)
**"Zytel" is the new trade-mark for Du Pont nylon resin.

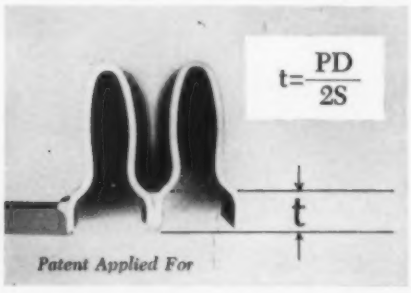
Sola-Flex expansion joints meet petrochem industrial needs

IN THE UNUSUAL installation pictured above, the vertical pipe equipped with a Sola-Flex joint at either end is 10 stories in the air and is suspended with counter weight spring hangers which support the 12,000 pound dead weight.

Sola-Flex expansion joints are now used and endorsed by all major oil companies, and conform with the API-ASME Codes.

Unique construction of the Sola-Flex U-span joint provides built-in stress rings as illustrated in the sketch below where $t = PD/2S$. This fully integrated design eliminates the need for separate external supports.

Sola-Flex catalogs offer a complete range of sizes in standard expansion joints, convoluted couplings and special designs to meet high or low pressure requirements. Customers can also depend on Solar engineering skill for the development of custom designs to solve special problems.



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SAN DIEGO
DES MOINES

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Solar specializes in the manufacture of precision products from alloys and special metals for severe service. Solar's experience since 1927 is unduplicated in this field. Solar skills and facilities range from research, design and development through to mass production. Wherever heat, corrosion or difficult specifications are problems, Solar can help you solve them.

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EQUIPMENT. *Production equipment for all types of metal fabrication —forming, machining, welding, brazing, casting, coating. Extensive laboratory and testing equipment. Facilities for development, prototype, limited or mass production.*

SERVICES. *Research, design, development, tooling and production engineering staffs. Experienced with all alloy steels, stainless alloys, super alloys, and titanium and its alloys. Government source inspection and Solar quality control meet rigid aircraft and commercial standards.*

CONTRACT PRODUCTION

Current orders include aircraft engine and airframe parts, alloy castings, pneumatic ducting, atomic energy components. Customers include some of the most honored names among aircraft and industrial companies in the U.S. and Europe.

SPECIAL PRODUCTS

Bellows. *"Sola-Flex"® bellows and expansion joints in many designs from ½ in. up to the world's largest, 28 ft. in diameter.*

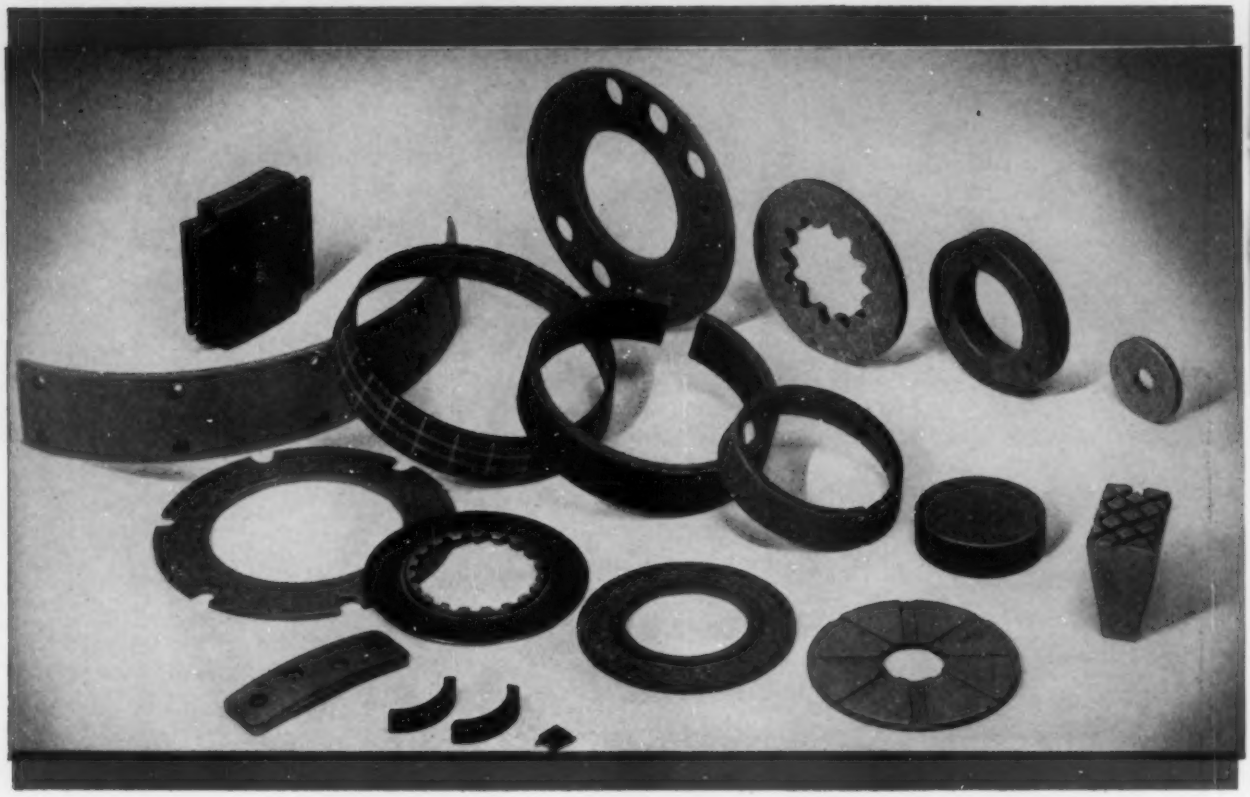
Gas Turbines. *Solar "Mars" 50 hp engines for auxiliary generator sets, ground carts, portable fire pumps; Solar "Jupiter" 500 hp engines in variable and constant speed models.*

Ceramic Coatings. *"Solaramic"® is the Solar trade mark for a family of coatings that protects metals from heat, corrosion, galling and abrasion.*

Controls. *Complete control systems utilizing the new Solar "Microjet"® principle for control of gas turbines, jet engines and pneumatic devices.*

FURTHER INFORMATION
Your inquiry regarding any Solar service or facility will receive prompt attention. Address Solar Aircraft Company, Department A-27, San Diego 12, California.

CALL ON R/M ENGINEERING SERVICE



PERHAPS YOU HAVE A FRICTION MATERIAL PROBLEM

If so, you will be interested to know that R/M is the world's largest maker of friction materials; that R/M makes friction material products for all types of equipment—from the lightest household or office appliance to the biggest train, truck or tractor; that R/M works in both the asbestos and metal fields—woven and molded asbestos, semi-metallic materials, and sintered metal are all in the picture.

Many of Raybestos-Manhattan's friction material products are the direct result of cooperation between design engineers and R/M research. One outstanding example of this teamwork is R/M's work with automotive engineers. It has resulted in there being an R/M part on every model of every automatic transmission made.

If you are designing or making a product which requires friction materials, you will find it helpful to call on R/M's specialized Friction Materials Engineering Service. Whatever your problems, whatever your requirements, R/M's experience, skills and facilities will be advantageous to you. For detailed information about R/M brake linings, clutch facings and special shapes of friction materials, send for booklet today.

For Bulletin No. 500, or other data, write, phone or wire:

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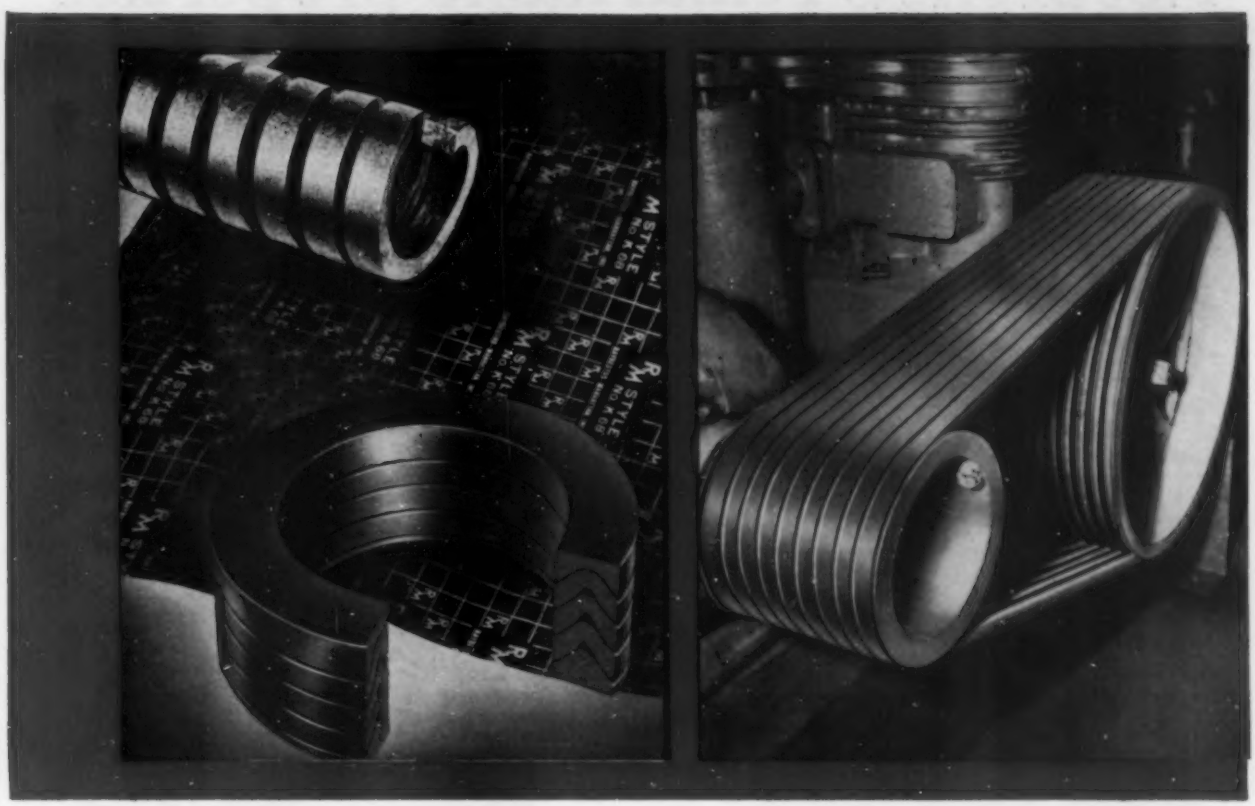
FOR HELP IN SOLVING YOUR PROBLEMS



PACKINGS, GASKETS, Asbestos Textiles and Teflon* products

For specialized packing engineering service call on Raybestos-Manhattan. R/M makes a complete line of packings and gasket sheets for use against air, gas, water, steam, oil, solvents, foods and hydraulic fluids. It also makes an unusual number of asbestos textiles and a wide variety of Teflon products. The many years' experience R/M has had in these fields can be put to work for you in an instant. Just say the word. Send for booklet on packings, gaskets, and Teflon products.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

For booklet shown, or other data, write, phone or wire:

PACKING DIVISION OR ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

R/M SUPER-POWER V-BELTS

With R/M Super-Power V-Belts you obtain up to 40% greater horsepower capacity over the same number of regular V-belts. You can save space as fewer belts are required. In addition, there is virtually no stretch and practically no matching problem. Made with new high strength synthetic cords. Straight sidewalls provide more grip, less slip, longer life. R/M Super-Power V-Belts are also oil-proof, non-spark, and heat-resistant. Bulletin 6628 contains details. Of course, Condor V-Belts continue to be the standard for regular service.

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Raybestos-Manhattan, Inc.
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Gregory 3-2000

RAYBESTOS-MANHATTAN, INC.

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Conveyor Belts

Rubber Lined and Covered Equipment

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Asbestos Textiles

Teflon Tape, Packings, Sheets, Rods, Tubes

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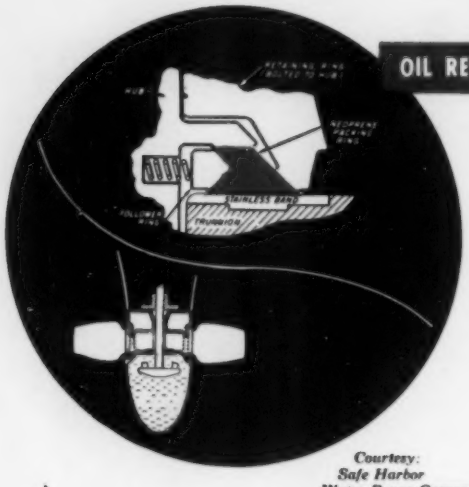
Neoprene's remarkable properties



Courtesy:
Safe Harbor
Water Power Corporation

OIL RESISTANCE | **ABRASION RESISTANCE** | **LOW COMPRESSION SET**

These properties of neoprene assured efficient operation of this HYDROTURBINE

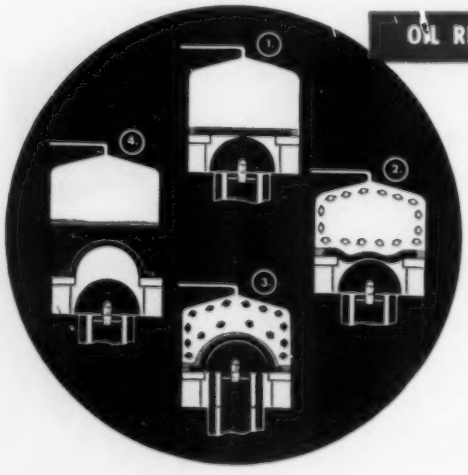
Encircling each trunnion of this hydroturbine is a neoprene packing ring. As the blades change pitch, the ring seals oil in and water out by pressing against the hub and a steel band on each trunnion. This key neoprene part resists attack from oil and grease . . . stands up under constant abrasion. And neoprene's low compression set assures that the tight seal will continue for years despite continuous pressure.

LOW COMPRESSION SET | **CHEMICAL RESISTANCE** | **ABRASION RESISTANCE**

These properties of neoprene made a more effective BUTTERFLY VALVE

The secret of this valve's perfect closing action—against low pressure or vacuum—is a resilient neoprene seat. When the valve is closed, this seat exerts positive pressure against the disk. If solid matter is caught between seal and disk, the seat deforms around it and the seal is maintained. And since neoprene resists abrasion, oils and chemicals, the valve can be used in a wide variety of applications.

Courtesy
Keystone
Foot Corporation,
P. O. Box 6716,
Houston 5, Texas

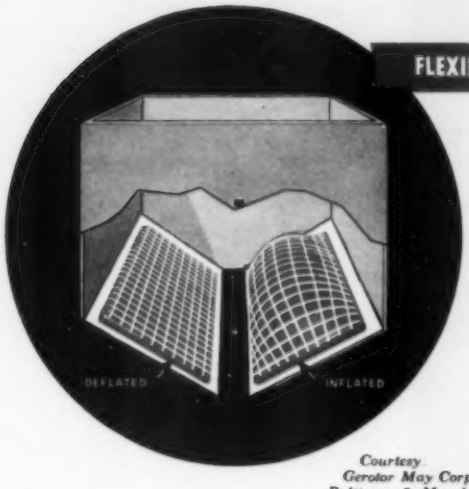


OIL RESISTANCE | **ABRASION RESISTANCE** | **FLEXIBILITY**

These properties of neoprene improved the operation of this HYDROFORMING PRESS

In this method of metal forming, a neoprene diaphragm backed by hydraulic oil acts as a universal female die. A metal blank is placed on a draw ring and the upper forming cavity, faced with the diaphragm, is locked in position (Fig. 1). Hydraulic pressure is increased (Fig. 2). The die punch is forced against the diaphragm into the forming cavity, wrapping the blank around the punch (Fig. 3). The cavity is raised, and the finished part stripped from the punch (Fig. 4). Even after thousands of such cycles, rugged diaphragms of neoprene remain resilient and free from cracks.

solve difficult problems in design



Courtesy
Gerotor May Corporation,
Baltimore 3, Maryland

FLEXIBILITY | **ABRASION RESISTANCE** | **CHEMICAL RESISTANCE**

These properties of neoprene increased the efficiency of this STORAGE BIN

Inflatable panels on the walls of this storage bin eliminate jamming of the contents. Each panel is an elastic neoprene diaphragm bonded to a steel plate. Fed by compressed air, the diaphragm balloons out, then collapses when pressure is released . . . keeps materials moving. Neoprene combines the flexibility required with the toughness to withstand severe abrasion. And because neoprene resists flex cracking and attack from oil and chemicals, the panel remains free from weak spots or leaks.

LOW COMPRESSION SET | **ABRASION RESISTANCE** | **OIL RESISTANCE**

These properties of neoprene proved ideal for a key part in this ROTARY LAWNMOWER

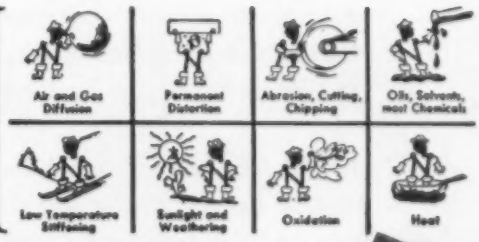
At the heart of this lawnmower is a shock-absorbing clutch—a fluted neoprene ring set between metal sleeves. If the blade strikes an obstruction, this ring remains locked to the outer sleeve, while the inner sleeve and crankshaft continue to rotate . . . squeezing past the resilient ring. Neoprene was specified for this critical part because it resists abrasion, grease and oil. And its low compression set means that the ring will retain its shape despite constant pressure and the shearing action of the sleeves.

Courtesy
Western Tool and Stamping Company,
Des Moines 13, Iowa

What's YOUR Design Problem?

Look over the list of neoprene's properties. If one or a combination of them is important to the design of your product, write us for complete technical data. Although Du Pont does not make any finished products of neoprene, our engineers will be glad to work with you and your rubber goods supplier on your individual problem. Write to: E. I. du Pont de Nemours & Co. (Inc.) Rubber Chemicals Div., PE-10, Wilmington 98, Del.

PROPERLY COMPOUNDED NEOPRENE WILL RESIST:



NEOPRENE

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DU PONT
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FREE! THE NEOPRENE NOTEBOOK

Each issue shows new, unusual applications of neoprene . . . new products . . . improved designs. The neoprene applications cited above are covered in detail. Add your name to the mailing list today.

E. I. du Pont de Nemours & Co. (Inc.)
Rubber Chemicals Division PE-10, Wilmington 98, Del.

*Name*_____ *Position*_____
*Firm*_____
*Address*_____
*City*_____ *State*_____

"Why," the sales manager said, "do we concentrate so much of our advertising in *Product Engineering?*"

This same question and answer undoubtedly find their place in conversations between hundreds of sales and advertising executives.
For over 850 sales managers, whose products are now advertised in *Product Engineering*, the question is a natural one . . . and the answer a very sound reason for *Product Engineering's* wide leadership as an advertising medium to design engineers.

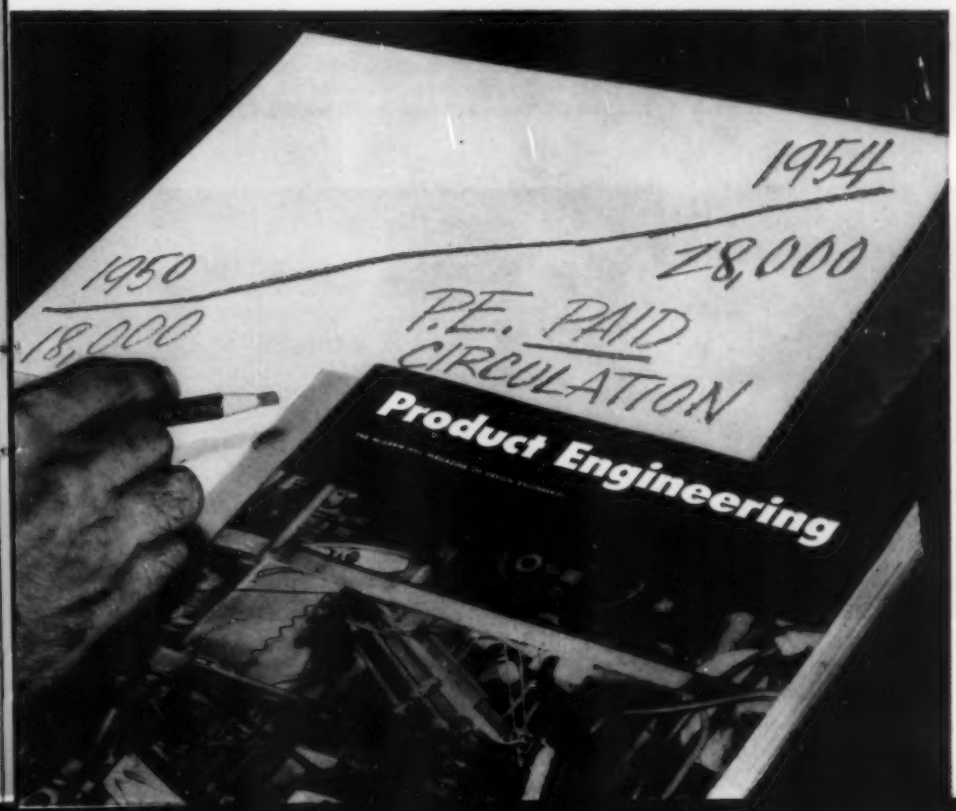
In just four years, *Product Engineering's* all-paid circulation has grown by 55%.*
And in contrast to the free distribution of all other design magazines, this *paid circulation* is the kind that grows only from the self-generated, insistent demand of design engineers for the help which *Product Engineering* alone can bring them. These basic buyers of industry, these *Product Engineering* subscribers, have read *Product Engineering* . . . liked what they read . . . evaluated the worth of this magazine to them . . . and then put their money on the line to have it.

**Product Engineering's* all-paid circulation with the June 1954 issue was 28,071, (subject to ABC audit)

And if, by chance, you should be asked what it *costs* to put the unmatched power of this magazine behind your products, with all the exclusive proof of readership it alone can give you, the surprising answer is:
"*Product Engineering's* cost-per-thousand is the lowest in its field."

This matter of offering the *most value* for the *least money* is perhaps the clincher to *Product Engineering's* dominant advertising position in the $28-billion Original Equipment Market. In the past 12 months, advertisers put over 1,000 more pages in *Product Engineering* than in any other design magazine. And if *you* want more original equipment business at less cost, you'll be value-wise, indeed, to put *Product Engineering* first on your schedules.

"Because," the advertising manager said, "it's the *only* magazine in the design field that can demonstrate *this kind* of ever-growing acceptance among design engineers."



THE MEN WHO DESIGN
AMERICA'S NEW PRODUCTS
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ABC ABP

The McGraw-Hill Magazine of Design Engineering
McGraw-Hill Building, New York 36

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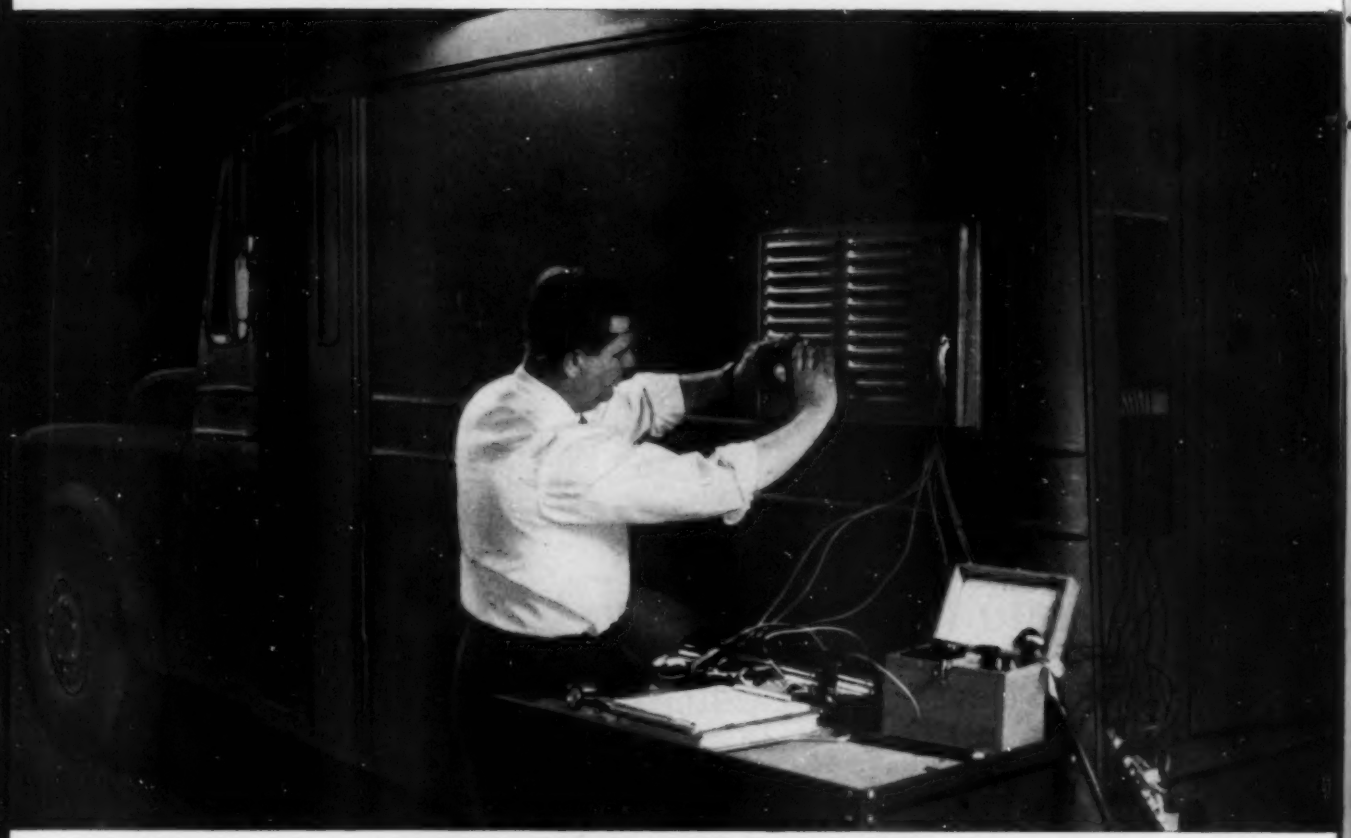
This Allen Cooler truck went right into our lab and proved . . .

Why it pays to ask for



G-E ENGINEERING solved a complex truck refrigeration problem for Allen Cooler. The General Electric system provides uniform temperature when operating off the engine drive or on 115-volt AC plug-in during off hours. System was created by modifying standard G-E components, including an alternator, a rectifier, and two fractional-hp motors, and adding a regulator.

1 **PROBLEM PRESENTED** to G.E. by Allen Cooler design engineers called for flexible 24-hour truck refrigeration, maximum storage capacity, and minimum cost.

2 **RIGHT INTO G-E LAB** went this home delivery truck. Laboratory study indicated design requirements, helped cut time needed to come up with final electrical system.

G-E motor application help

G-E engineers design electrical system to provide low-cost truck refrigeration during deliveries . . . plus overnight plug-in service

If you have a difficult motor application problem, you'll find it pays to take advantage of the technical skills and the resourceful engineering of General Electric's Specialty Component Motor Department. Here's how Allen Cooler profited:

Allen Cooler design engineers wanted this: an electrical system for refrigerating milk delivery trucks which would operate at full cooling capacity at engine idling speed. An additional requirement was that the system also operate on 115-volt AC during off hours, thus providing 24-hour service. However operated, the system should maintain temperatures between 35 and 40 degrees at all times.

G-E motor engineers went to work on these specifications. They devised a packaged electrical system incorporating an alternator, a compressor-drive motor, an evaporator motor, a regulator, and a rectifier. Made up of these skillfully integrated components, the compact system provides reliable cooling with maximum truck-storage capacity.

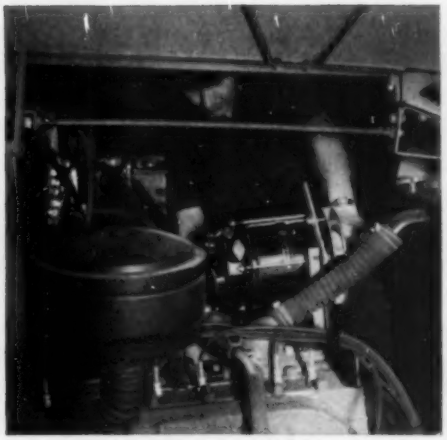
Working closely with the Allen Cooler engineers, General Electric engineers installed the packaged system in a dairy truck and tested it under actual operating conditions. The amazing performance: during 6000 miles of hot weather service, there was not a single operational complaint.

Next time you have a tough motor application problem, bring it to General Electric. You'll be taking advantage of engineering skills unmatched anywhere. To arrange for this service, contact your nearby G-E Apparatus Sales Office. For more information, write General Electric Company, Section 704-27, Schenectady 5, New York.

Progress is our most important product

GENERAL ELECTRIC

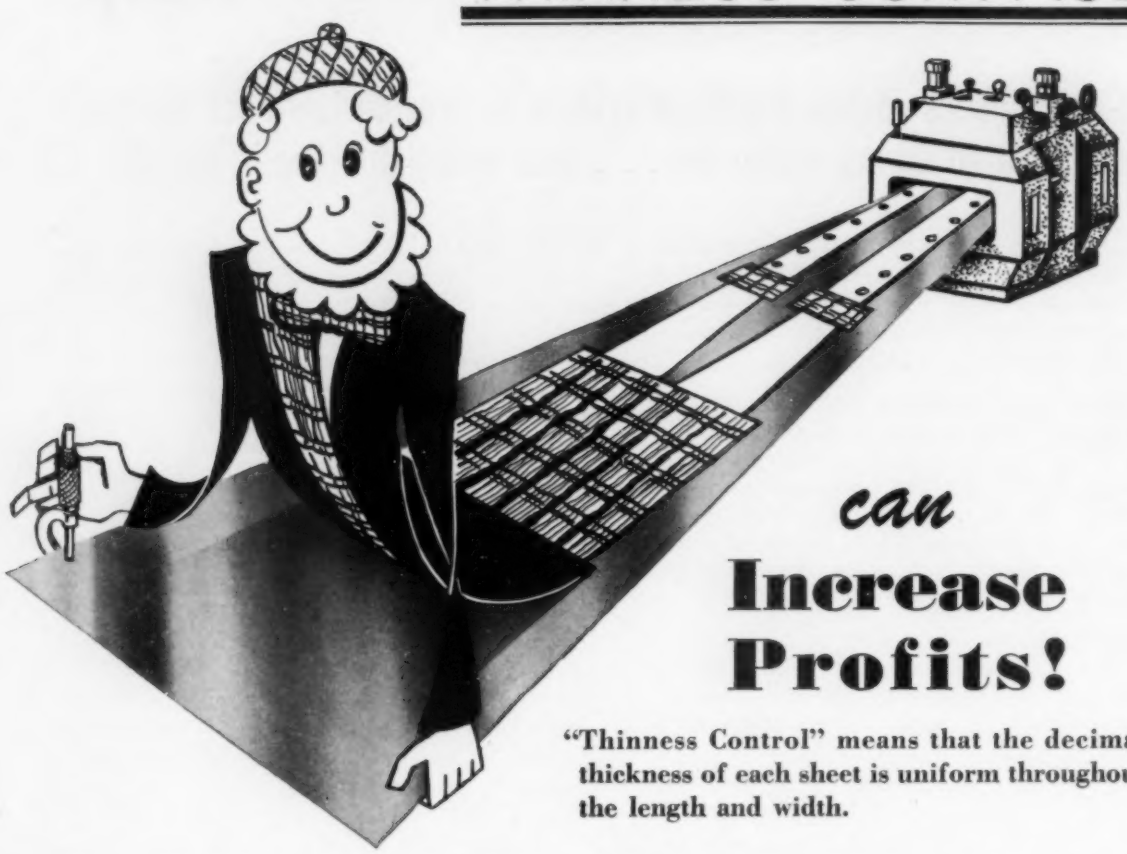
3 **ACTUAL CONDITIONS** of operation were simulated. In this cell, temperature control accuracy was checked.



4 **INSTALLATION OF ALTERNATOR** under truck's hood. Unit must withstand heat, be compact, yet provide sufficient capacity.

5 **FINAL UNIT** uses minimum space, maintains even temperatures during deliveries, permits plug-in service.

MicroRold® THINNESS CONTROL



can Increase Profits!

"Thinness Control" means that the decimal thickness of each sheet is uniform throughout the length and width.

Job costs are figured on a square foot basis while stainless steel is purchased on a weight basis. When stainless steel is ordered by gauge number the permissible A.I.S.I. thickness variation is plus or minus 10%. If you receive material on the heavy side of the gauge range you are paying a premium for stainless surface area. For example, if you order 18 gauge, you may receive sheets .052″ thick, when a thickness of .0475″ would suit your purpose. On a standard 18 gauge sheet (36″x120″) each .001″ in thickness weighs 1.26 pounds per sheet. In this example, each stainless sheet could weigh as much as 5.67 pounds more than required. You can readily see the advantages of specifying stainless rolled to the light side of the gauge range. MicroRold stainless is rolled to exceptionally close tolerances, as low as 3% average (plus or minus). Regular use of MicroRold provides more stainless area per ton or the equivalent area with lesser weight.

If you are not now a user of MicroRold sheet it will pay you to get the full details. Your steel distributor will gladly tell you the MicroRold story.

Washington Steel Corporation

WASHINGTON PENNSYLVANIA

Perspectives

DESIGN AND DEVELOPMENT

GERMANS BOUNCE BACK

Bombed and battered during World War II, and confiscated shortly after, Germany's machine tool industry has completely regained its prewar prominence. Now in second place, outranked only by the U.S., the industry rang up a sales volume of about $238-million in 1953. About half of the total production was exported, as compared to only 35 to 40 percent in 1938. A comparison by weight also shows an increase of roughly 30 percent over 1938. The following table indicates Germany's strong comeback in the world's market since 1950:

	Total	*Cutting*	*Non-cutting*
1950	$ 33,705,000	$ 19,105,000	$11,153,000
1951	$ 71,464,000	$ 48,003,000	$19,031,000
1952	$139,926,000	$105,676,000	$31,912,000
1953	$135,856,000	$101,306,000	$31,497,000

These figures show the value of exports of machine tools from West Germany, including those from West Berlin. Figures listed under "total" are higher than the sum of "cutting" and "non-cutting", since they include some tools that cannot normally be classified in these two categories. Of the 1952 total, $17,078,000 was to the U.S. In 1953 the figure was $12,720,000.

AMERICAN AID

American aid has helped greatly, particularly in the early years of recovery after the end of hostilities. Funds amounting to $22.5-million were pumped into the industrial machine sector in Germany; and of this total, the machine tool industry received $5.8-million, or about 25.9 percent. These funds were in the nature of loans and are being repaid by the individual firms to the German government.

Export and production figures in 1954 are not expected to exceed those of 1953 by too great a margin; but German industrial circles are traditionally pessimistic, and 1954 may well turn out to be another good year for the industry. It is true, however, that the boom which set in during the Korean trouble, has, to a great extent, levelled off. During Korea, delivery schedules were often as high as 18 to 24 months. Now, most of the machines, with the exception of special orders, are available under eight months. Secondly, the "buy-on-time" programs inaugurated by some of the larger U. S. machine tool builders, have been making inroads on Germany's export business.

NEW DESIGN IDEAS

Because of the war damage, and the loss of the East zone to the Russians, many of the German machine tool makers were forced to start from scratch. While the semi-automatic machines, turret lathes, and jig borers show the greatest improvement designwise, the Germans admit that they have not

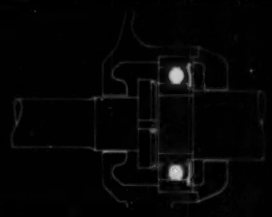
(Continued on page 125)

Here's another reason why

the NEW L.A. *Line*

by the Louis Allis Co.

is your BEST *electric motor* BUY



Shaft extension bearing construction used in new L.A. open, drip-proof motors. Note the Louis Allis bearing-cap construction. It locks outer bearing race to cap, inner race to shaft.

New L.A. open drip-proof motors

A brand-new power package, completely redesigned inside and out

with NEW BEARING CONSTRUCTION

plus

New modern styling
More compact design
New conduit box arrangement
Improved ventilation and better protection
More versatile mounting

HERE'S the locked bearing construction that makes the new L.A. motors even better—gives them extra life, extra dependability. It positions the rotor . . . limits shaft end-play . . . gives you ample V-belt drive capacity. You get factory prelubrication, too, with a new, improved grease-retaining system that saves servicing and maintenance — for years of attention-free operation under most conditions.

That's not all! You get standard bearings in every unit — sizes specially selected to be easily obtainable from local stocks. And there's no need to tear the motor down to get bearing numbers — they're stamped right on the new motor nameplate.

Add this modern, dependable bearing construction to all the other features and you see why the L.A. line is your best motor buy. Get the complete story from your nearby Louis Allis Sales Engineer.

We specialize in SPECIAL MOTORS *and* PROMPT DELIVERY, TOO

There's a Louis Allis special motor for your toughest application. Whatever electrical or mechanical modifications you need, check first with Louis Allis.

Vertical NEMA C-flange motor

NEMA D-flange motor

NEMA C-flange motor

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

LA-105

come up with any drastic new developments in the design field. Quite the contrary. Many of them have taken a good look at the American design, with the result that many of their new machine tools contain American ideas on design and construction.

One of the basic drawbacks of prewar German machine tools, the Germans are quick to admit, was their relatively weak construction. All too frequently efficient operation depended on an extremely strong foundation, with the result that the machines could not be switched around within a plant, or from one plant to another. The German always has admired the sturdy construction, based on the stronger cast iron, of the American machine tools. As one German put it: "That's what I like about your machines: you can literally set them up anywhere and they will work efficiently. Now with German tools you cannot do this; you are forced to stay with your foundation site." New designs will do away with this.

MASS PRODUCTION TOOLS

Another basic difference in thinking is that the Germans do not produce machine tools built for the type of mass production jobs so common in this country. For example, the transfer machines in their automobile plants are not as highly automatized as those found in the U. S. The reason being that with their low production and low labor costs, it does not pay to have machines of this type installed. The German tools are built for smaller production jobs, and must be capable of being adapted to several jobs instead of just one. As a consequence, the Germans tend to build more universal or multi-purpose machine tools. This trend, however, has made some of the machines so complicated, with special attachments and complicated operating devices, that German plant managers sometimes throw up their hands in despair. Said one: "We almost need university-trained specialists now to operate some of our machines; but those American machines, usually built for just one job, can be operated by the average worker."

CUSTOM MADE

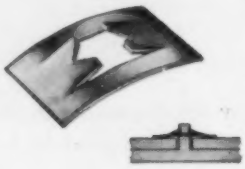
But it is the German willingness to build any type of machine tool desired by the customer that enables them to hold their position in the world markets today. With their lower design and development costs they can afford to build the special machine. For example, in designing for the American market, German machine tool designers look for an operation that requires, say, 65-70 percent labor and 30-35 percent material, then try to design a machine that will substantially reduce the labor in that operation.

Generally, in Germany there is no criticism of the U. S. machine tools compared to German models except that, "they are much too expensive for us." This is perhaps due in part to the fact that U. S. machines usually have much more horsepower than is needed. The reason being that they can be overloaded. One German plant has a German and an American machine tool for the same job. The U. S. model cost about $12,500 more than the German one.

But the counterpart of the U. S. mania for designing excessive horsepower into their machines, is the German's professional pride in accuracy and fine tolerances which he designs into machines where it is not needed.

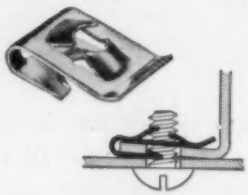
FLAT TYPE

One-piece self-locking spring steel fasteners. Replace threaded nuts, lock washers or spanner washers. Available in a wide variety of shapes and screw sizes.



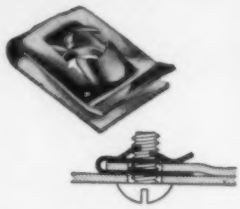
PUSH-ON

Zip over unthreaded die cast or plastic studs, rivets, nails, tubing, or wire to lock parts securely. Removable types available in many sizes.



"J" TYPE

Snap over edge of panels and into center hole locations. Hold themselves in place for blind assembly. Full range of panel thicknesses and screw sizes available.

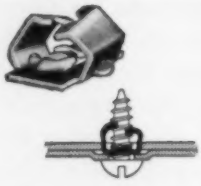


"U" TYPE

Perform same function as "J" type for reduced materials handling. Used where full bearing on lower leg of the SPEED NUT is required.

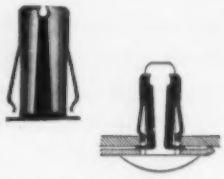
LATCH TYPE

Easily applied by hand, are self-retained in bolt-receiving position at center panel locations for blind attachments. Front mounting types are also available.



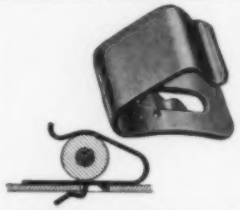
EXPANSION TYPE

For lightning-fast attachments in blind locations. Snap into mounting holes by hand. Screw spreads spring fingers, wedge-locks part in position. Secure, vibration-proof attachment.



TUBULAR CLIPS

For use with unthreaded studs or rivets. Virtually "nails" panels together where there is access to one side only. Permanent lock or removable types.

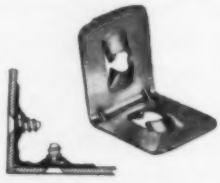


CABLE, WIRE, AND TUBE RETAINERS

Snap in place by hand, self-retained in position to receive wide range of cable, wire and tube sizes. Easily removed for service or re-location.

HARNESS CLAMPS

Open or close by hand — no tools needed. Attach to panel or pre-assemble to harness before installation. Cushioned to protect wires. Cannot open accidentally.

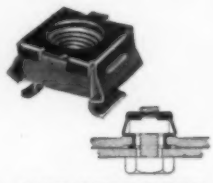


ANGLE BRACKETS

Combine bracket and fastener to reduce number of parts, speed up assembly and strengthen the structure. Variety of shapes and sizes.

HOSE CLAMPS

Self-locking, ratchet-type design, one-piece low profile construction — no bolts, nuts or thumb screws. Fast and easy to apply and remove for medium- and low-pressure connections.



NUT RETAINERS

Retain square nuts in blind locations. No welding, clinching, staking — snap in by hand. Provided in a wide range of screw sizes. "U" and "J" type retainers available.

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Assembly cost savings from 30% to 75% . . . increased product quality . . . reduced materials handling . . . far less field service problems. These are a few of the reasons why more and more manufacturers are specifying SPEED NUT brand fasteners. Write today for your copy of "Savings Stories"—a book full of cost-saving fastening reports. TINNERMAN PRODUCTS, INC., Box 6688, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine).

Alexander Was Not Great

WHEN ALEXANDER FOUND OUT that his mother was plotting the death of his father, the king. he had the choice of warning his father or allowing him to be killed. Alexander chose to keep quiet and that is how he became king at the age of 29. Mentally brilliant, ambitious and ruthless or lenient, as served his purpose best, he took over the generalship of the Macedonian army that he had inherited from his father and set out to conquer the world.

Alexander dominated all with whom he came in contact. Those whom he could not bend to his will, he executed. He personally lead his army, planned the campaigns and made the military decisions. Unable to find peace of mind, perhaps because of the part he had played in the murder of his father, he was goaded ever onward to more distant lands to conquer. His road was marked with pillage, death and destruction except where he felt sure that he could, by bribery or otherwise, make the region a satellite.

Finally in Babylon, at the age of 42, after a heavy drinking party, Alexander was struck down with a fever and in 12 days was dead. His kingdom soon fell to pieces, mute testimony to the fact that his life's work was neither altruistically good nor stable. Yet in the pages of history he is called Alexander the Great. Thus does the human weakness of hero worship warp man's sense of values.

Hero worship is a common weakness. Even in business, which loves to pride itself on being hard headed, decisions are based only too often on hero worship. The one who gets promoted is the ruddy faced, cheerful, flattering young man who has spent much of his time cultivating the boss, belittling his associates and stealing the credit for their accomplishments. The faithful employee, though the better producer, and a respected true leader, is too often ignored or discredited.

Every executive should be extremely wary of the fellow who flatters, who is always quick to agree but rarely takes a positive stand. He is the man who holds his associates up to ridicule for the mistakes they make. He smoothly shifts responsibility for his own mistakes and takes credit for what others have done. With a cheerful smile he dams with faint praise and otherwise belittles outstanding accomplishments.

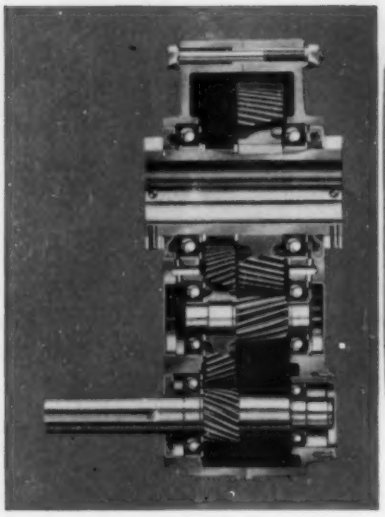
He is lauded as a "bright young man with a charming personality, who gets things done and is always affable and cheerful". On his road to high position he leaves behind crushed men whose careers he had wrecked, bitter men whom he had exploited, bosses he had betrayed.

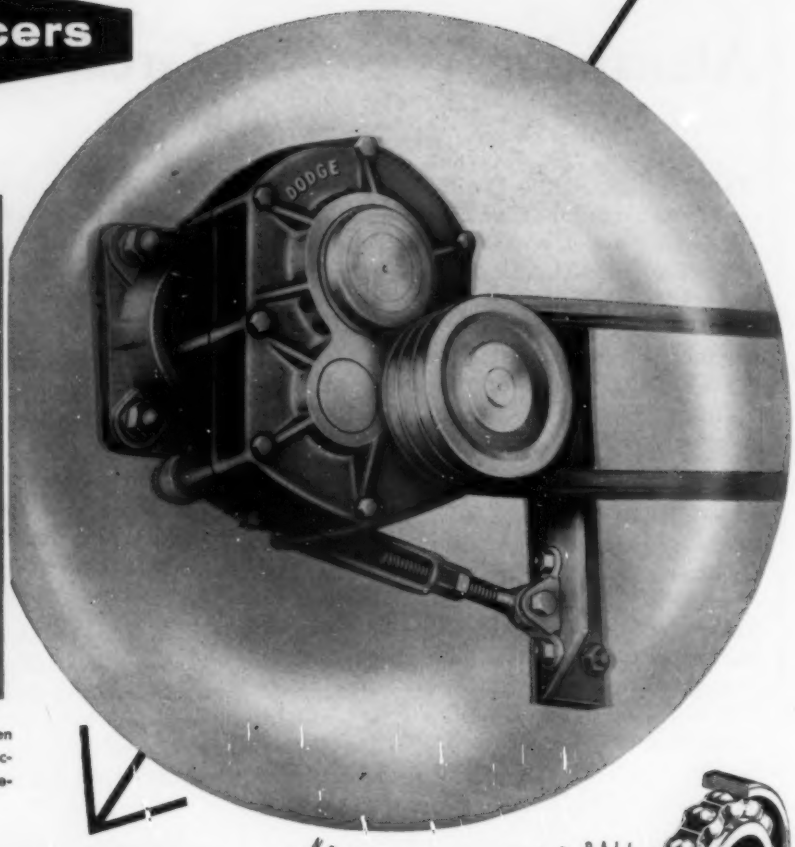
Nothing is more destructive to the morale and performance of an organization than to have the boss "taken in" by the scheming flattery of a brilliant but unprincipled seeker after promotion. The same human weakness of hero worship that labelled Alexander as being great also tends to hide the fraudulent character and low worth of those bright smiling schemers who try to climb on the performance and abilities of others.

Alexander was not great.

George F. Rodenhoff

Reducing Costs in Speed Reducers





New Departure **ball** bearings are used in seven basic sizes of the Dodge single and double reduction speed reducers, handling from 1 to 43 horsepower at output speeds from 12 to 330 r.p.m.

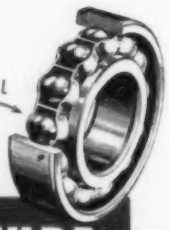
. . . with NEW DEPARTURES

Dodge Manufacturing Corporation's Speed Reducers make good use of design advantages offered by New Departure snap-ring **ball** bearings.

The snap rings locate the bearings in the case, eliminating the need for adjustment. Doing away with threaded or shim-type devices permits straight-through boring of the housing. Thus split-case construction is highly practical, and assembly is greatly simplified. The result is a rigid, highly efficient unit, and one in which production costs have been kept to the minimum.

Learn what New Departure can do for *your* product. Talk with your New Departure sales engineer—*today!*

NOTHING ROLLS LIKE A BALL



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NEW YORK	1775 Broadway	Circle 6-1540	**INDIANAPOLIS**	1357 W. 18th St.	Imperial 4680	**LOS ANGELES**	5035 Gifford Ave.	Logan 8-2301
PHILADELPHIA	850 E. Luzerne St.	Garfield 3-4136	**PITTSBURGH**	Cathedral Mansions	Mayflower 1-8100	**BERKELEY**	1716 Fourth St.	Landscape 6-8750
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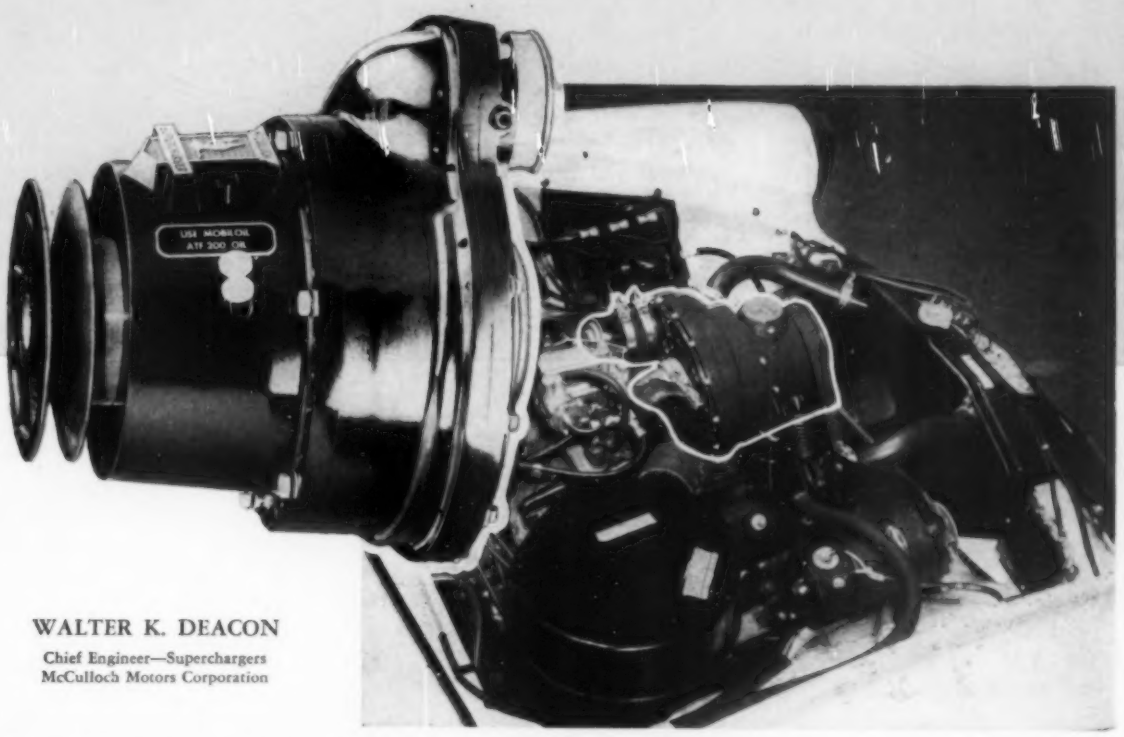
Supercharging for Increased Performance In Automotive Power Plants

Supercharging of portable or moving power plants can . . . .

(1) Increase payload of trucks by improving horsepower and torque. (2) Improve operating efficiencies of earth moving machinery by making available additional reserve power. (3) Make available higher cruising speeds and acceleration for automobiles without increasing weight or sacrificing fuel economy of the internal combustion engine.



WALTER K. DEACON
Chief Engineer—Superchargers
McCulloch Motors Corporation

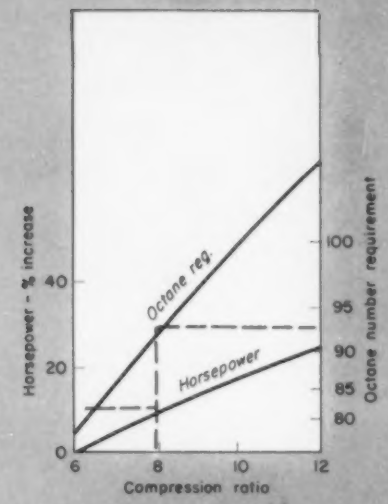


Fig. 1—Effect of compression ratio on horsepower and octane requirement of an engine.

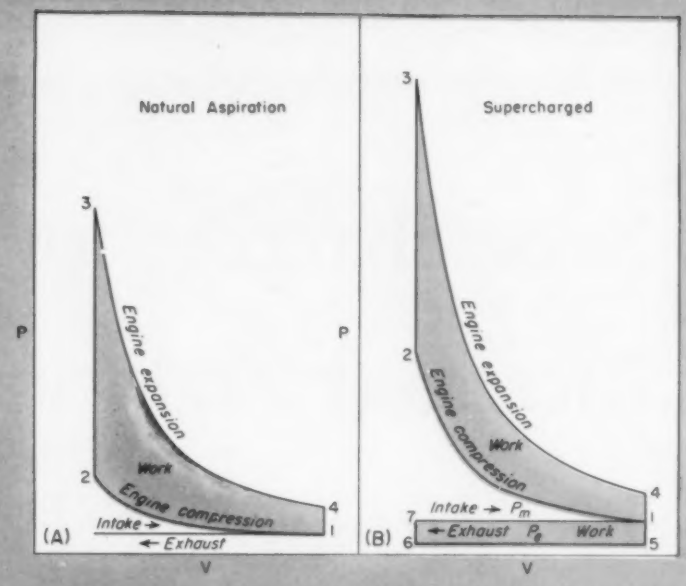


Fig. 2—Theoretical indicator cards for a standard internal combustion engine and a supercharged engine. Note increase in work area through supercharging of the engine.

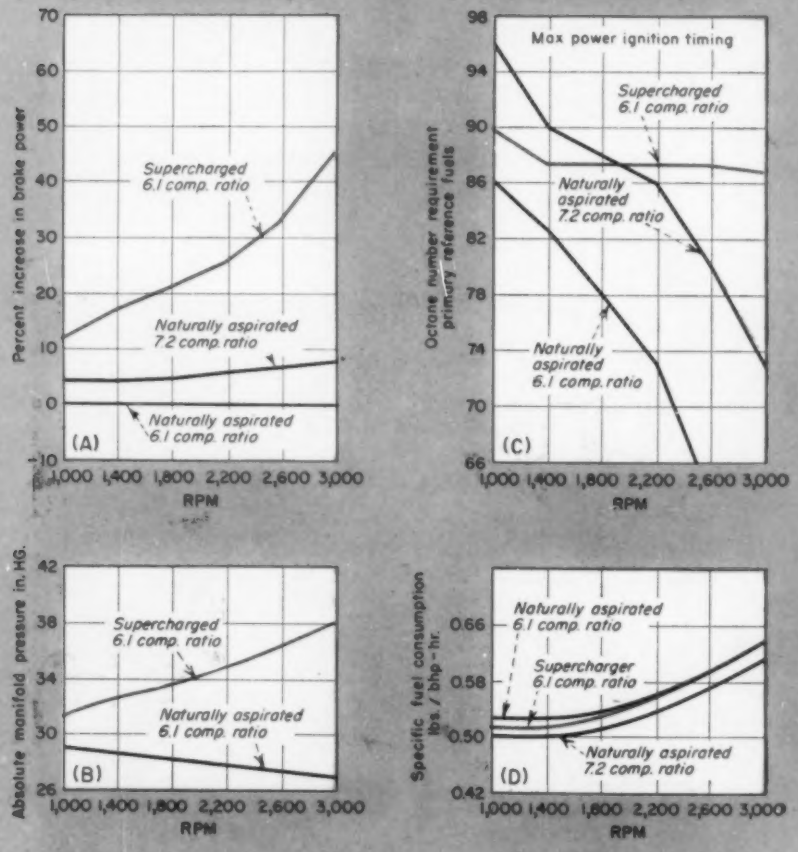

Percent increase in brake power
Supercharged 6.1 comp. ratio
Naturally aspirated 7.2 comp. ratio
Naturally aspirated 6.1 comp. ratio
(A)
RPM
Octane number requirement primary reference fuels
Max power ignition timing
Supercharged 6.1 comp. ratio
Naturally aspirated 7.2 comp. ratio
Naturally aspirated 6.1 comp. ratio
(C)
Absolute manifold pressure in. HG.
Supercharged 6.1 comp. ratio
Naturally aspirated 6.1 comp. ratio
(B)
Specific fuel consumption lbs. / bhp - hr.
Naturally aspirated 6.1 comp. ratio
Supercharger 6.1 comp. ratio
Naturally aspirated 7.2 comp. ratio
(D)
1,000 1,400 1,800 2,200 2,600 3,000

Fig. 3—Comparison of supercharging and increasing the compression ratio of a truck engine. (A) shows the bhp increase by supercharging over increasing compression ratio. (B) indicates the pressure developed by the supercharger. (C) shows the affect of compression ratio and supercharging on the fuel octane number required. Note that supercharged engine has a lower fuel requirement than 7.2 ratio engine and delivers 35 per cent more horsepower. (D) shows the variation in specific fuel consumption. Higher octane number fuel is used for the 7.2 ratio engine than for the 6.1 engine.

SMALL INCREASES in engine performance can be made by increasing compression ratio, improving engine volumetric efficiency, installing more complex and expensive carburetors and increasing engine speed. The gains are, however, limited by available fuels, acceptable noise level and smoothness of operation. For instance: Fig. 1 indicates the relatively small performance gains that can be expected from increasing compression ratio. The horsepower increases about 10 percent for a change in compression ratio from 6:1 to 8:1. The octane rating jumps from 78 to 92, which is about the limit of present day premium engine fuels.

Supercharging—on the other hand —increases the inlet charge density without decreasing the clearance volume; thus developing more power for the same effective compression ratio and fuel requirement. This is done by increasing the output per revolution of the engine by increasing the quantities of air-fuel mixture entering the engine during each intake stroke. Mechanical means are used to compress and deliver the air to the engine at a higher pressure and density. For example: an examination of Fig. 2 reveals that the inlet pressure exceeds the exhaust pressure by some value $P_m - P_e$, and results in a work increase represented by the area 5-6-7-1 being performed in addition to the power part of the cycle, 1-2-3-4. The curves of Fig. 3 further demonstrate the results of both supercharging and changing compression ratio of a high performance truck engine.

The added horsepower developed by supercharging will have an effect upon the engine structural and cooling characteristics. However, considerably more power can be developed by supercharging for a given increase in engine weight than by raising the compression ratio. Fig. 4 indicates the increase in indicated mean effective pressure (imep) for a given increase in maximum cylinder pressure. For example: if the compression ratio is increased from 5:1 to 8:1 at 30 in. Hg abs manifold pressure, the imep changes from 201 to 220, and the maximum cylinder pressure rises from 720 to 1,175 psi. Now, if the compression is kept constant at 5:1 and the engine supercharged to reach the same maximum cylinder pressure; a manifold pressure of 45 in. Hg. abs. gives about the same peak pressure but results in an indicated mep of 310 psi. In the example above the magnitude of the cylinder pressure may be considered to represent the weight of the engine, since it will influence the weight of the parts to a major extent.

Most engines must be designed to take some overload and if the supercharger is only used for short periods —as in the instance of the automobile engine—the extra power developed during these periods may have little effect on engine life.

The heat lost to the coolant will increase with engine output, and the water jacket or cooling fins must be capable of handling the extra cooling required. In most high speed engines the heat rejection does not increase in direct proportion to the power output which makes this problem less severe than others. (See Fig. 5).

Example of Supercharger Selection

Assume that a high speed truck engine is to be increased in performance by at least 30 percent. The engine is not to be materially altered or is a special fuel to be used. The engine has a displacement of 330 cu in. and is governed at 3,000 rpm. The compression ratio is 6.4:1. The engine performance is indicated in Fig. 6. Fig. 7 shows the fuel octane requirement.

Data on friction horsepower (fhp) and indicated horsepower (ihp) are not available so the engine airflow must be estimated from the brake horsepower (bhp) and the specific fuel consumption (sfc) by making the further assumption that the fuel-air ratio is 0.078. The airflow can be calculated from

$$W_a = \frac{sfc \times bhp}{F/a} \qquad (1)$$

Where:

W_a = weight of air
F/a = fuel-air ratio

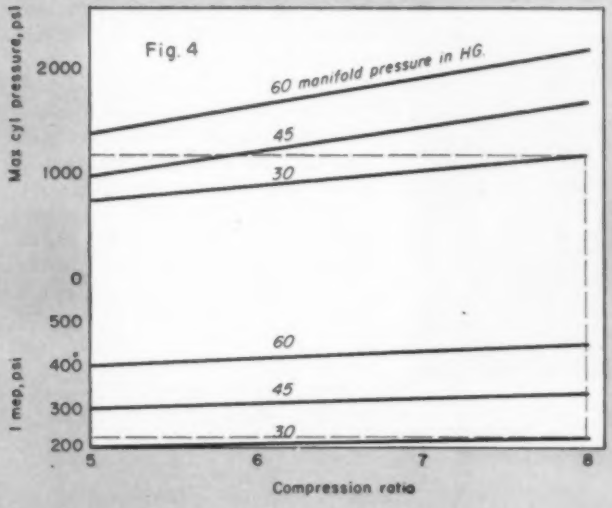


Fig. 4—Maximum cylinder pressure and indicated mean effective pressure vs compression ratio of a standard automobile engine.

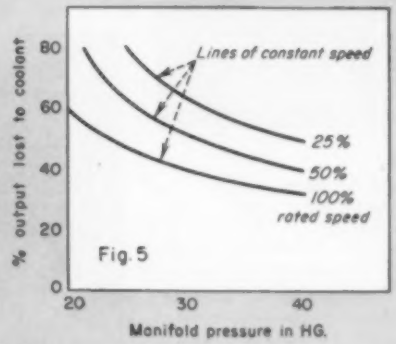
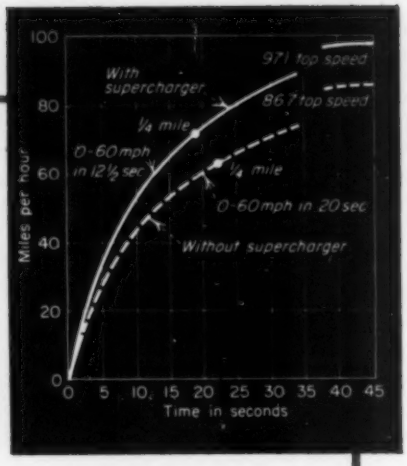


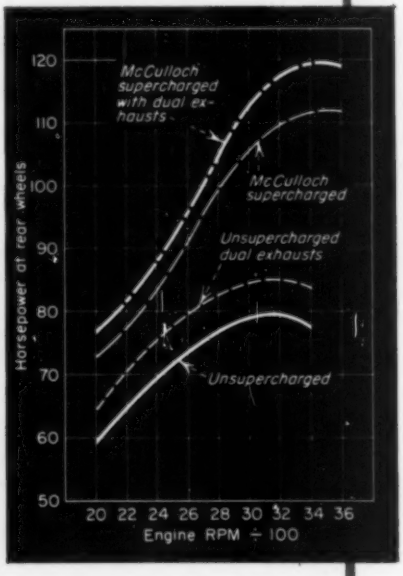
Fig. 5—Heat loss to coolant at various operating speeds for internal combustion engines.

IMPROVED PERFORMANCE

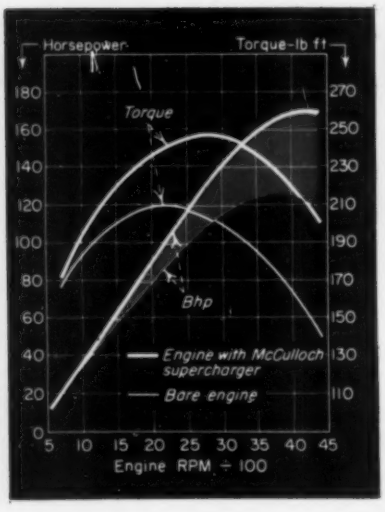
The comparison between horsepower, torque, velocity, acceleration and fuel consumption of a stock passenger car, with and without supercharger, are illustrated in the following curves. For consistency, curves all refer to the same automobile—a typical 8 cylinder engine car—and except where noted a standard and supercharged engine are compared. The supercharger is the McCulloch Model VS-57 which has a designed operating pressure of 5 psi, 1,400 lb/hr at 29,000 rpm. With a power increase of approximately 30 per cent at 4500 rpm, pick-up was improved as follows: without supercharging, 0-60 mph in 20 sec; with supercharging, 0-60 mph in 12½ sec. Top speed was increased from 86.7 to 97.1 mph.



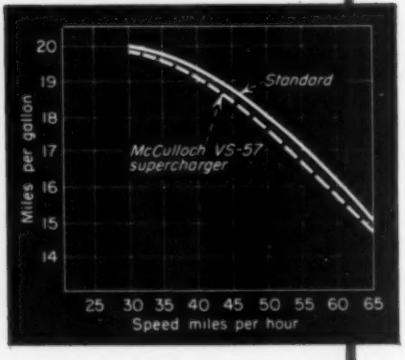
(A) Acceleration and top speed curves of a test car equipped with dual exhausts.



(B) Comparison curves of horsepower at the rear wheels as shown by dynamometer tests.



(C) Torque and horsepower vs engine rpm for a typical 8 cylinder automotive engine.



(D) Fuel economy curves for test car equipped with dual exhausts.

Most modern engines require 7-9 lb air per bhp-hr, depending on the compression ratio, engine friction and other variables. Fig. 8 shows the estimated air required.

To obtain the desired 30 percent power increase, the engine must be made to burn approximately the same percentage increase of fuel-air mixture. The density of the inlet charge must be increased a similar amount. These values are only approximate but serve as a means of selecting the supercharger size.

To estimate the compression ratio of the compressor an adiabatic compression is assumed:

$$\frac{P_2}{P_1}\left(\frac{\rho_2}{\rho_1}\right)^k \qquad (2)$$

Where:

k = adiabatic constant
P_2 = discharge pressure from compressor
P_1 = inlet pressure to compressor
ρ_2 = discharge density
ρ_1 = inlet density

$$\frac{P_2}{P_1} = R = (1.3)^{1.4} = 1.445$$

Where: R = compression ratio of compressor

Therefore

$$P_2 = 14.7 \times 1.445 = 21.2 \ psia$$
$$\Delta P = 21.2 - 14.7 = 6.5 \ psia$$

From Fig. 8 the maximum airflow required at 3,000 rpm can be found:

$$1.3 \times 925 = 1{,}200 \ lb/hr \qquad (3)$$

The above data are sufficient to select the size supercharger needed but first, the type of supercharger (Table I) required must be considered. For this example—that of a truck application—it is desirable that the greatest permissible power increase be attained at the lower speeds as well as design speed. In addition, the supercharger should not adversely affect part load economy and should be relatively quiet.

A centrifugal supercharger, Fig. 9, will be used. This particular unit—McCulloch model VS-57—is driven by a variable speed Vee belt from a pulley mounted on the crankshaft. The variable drive allows maximum supercharger pressures, at low engine speeds. Also, the drive permits the unit to turn at low speeds during cruising, thus greatly reducing the power required to drive it when compressor boost is not required.

A performance chart for the supercharger is illustrated in Fig. 10. The adiabatic efficiency for the estimated

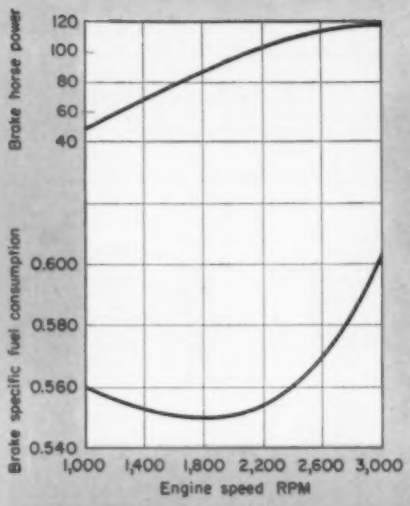


Fig. 6—Brake hp and brake sfc vs engine speed for a 330 cu in. displacement truck engine.

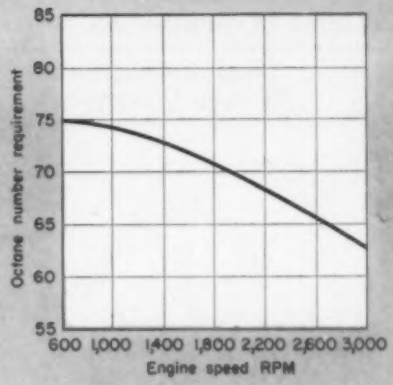


Fig. 7—Fuel octane requirements vs engine speed for a 330 cu in. displacement truck engine.

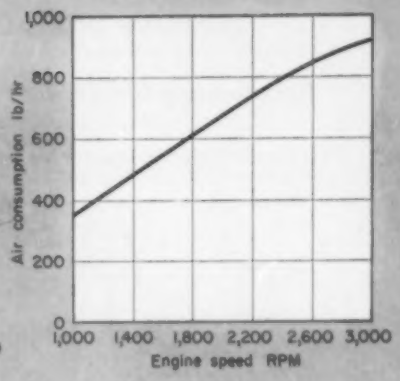


Fig. 8—Estimated engine air flow vs engine speed for a 330 cu in. displacement engine.

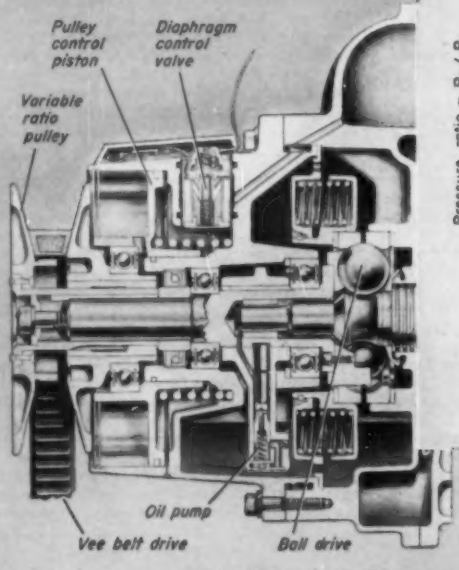


Fig. 9—Mechanically driven centrifugal supercharger. A variable diameter pulley drives the supercharger by means of a Vee belt connected to a second pulley at the engine crankshaft.

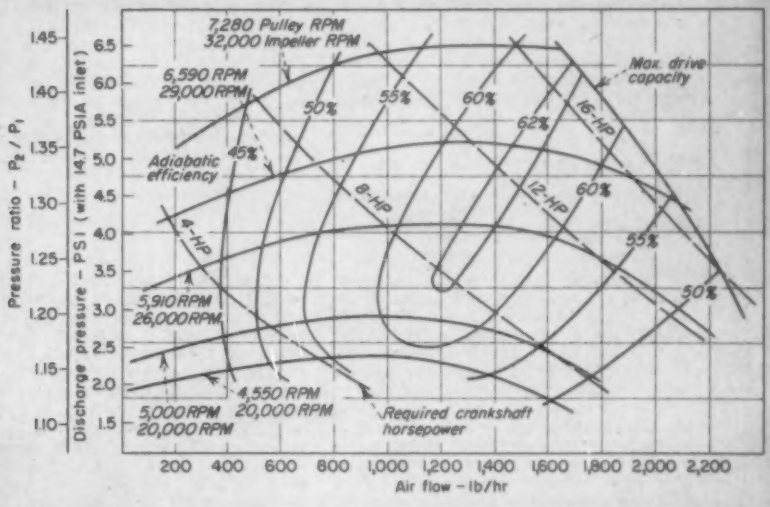


Fig. 10—Centrifugal supercharger performance curves for various pressure ratios and compressor speeds.

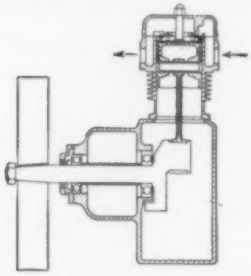
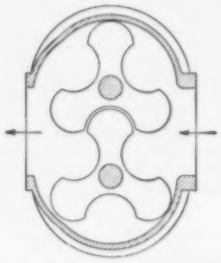
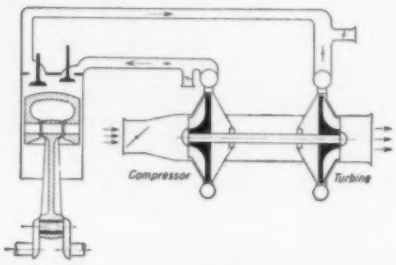
design point—1.45 and 1,200 lb/hr—is approximately 56 per cent. With this additional information it is possible to go back through the power calculation and obtain a closer estimate of the performance increase.

Supercharging an engine changes the inlet temperature, inlet pressure, the pumping work, and the volumetric efficiency. All these factors affect the performance and must be integrated to find the resultant change in power. Exhaust back pressure will also affect performance if the exhaust causes any appreciable restriction. Changes in engine friction, water jacket temperature, and other factors are considered to be of secondary importance and will be neglected in this example.

Using the pressure ratio, the compressor efficiency and an inlet temperature, it is possible to determine the inlet conditions to the engine. It is advantageous to use outside air temperature at 60 F rather than underhood air for the supercharger, since the temperature rise through the compressor will be sufficient to provide good fuel evaporization.

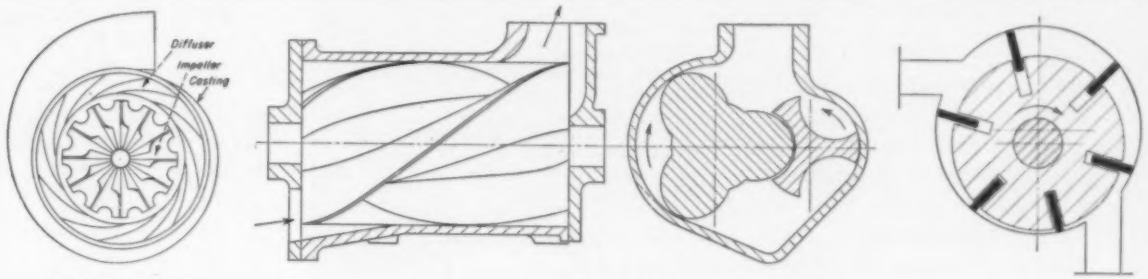
The compressor discharge pressure,

TABLE I—CLASSIFICATIONS OF SUPERCHARGERS

POSITIVE DISPLACEMENT COMPRESSORS		CENTRIFUGAL
Reciprocating Compressor	Displacement Blower Without Compression	Turbo Superchargers
Distinguishing Characteristics		
 Reciprocating Compressor	 Displacement Blower without Compression	 Turbine
Consists of a piston driven by a crank and connecting rod from the crankshaft of the engine. In some instances, a multiple of engine speed can be used if the mechanism, valve and other parts can withstand wear and work efficiently at high speeds.	Two or three counter rotating involutes are mounted on parallel shafts that are connected by gears causing the impellers to rotate in opposite directions. Close clearances between the case and impellers are required to reduce air leakage or slippage. With good design the slippage is small at high speeds and increases as the speed is reduced. The friction loss is about that of the involute shaft bearings plus gear loss.	These units are centrifugal compressors that are driven by exhaust gas turbines instead of by mechanical means. Approximately 60 percent of the heat input of the average internal combustion engine is lost in the form of exhaust gas heat energy. By increasing the exhaust pressure and passing it through a turbine where adiabatic expansion takes place in turbine nozzle pressure energy is converted to kinetic energy.
Operating Characteristics		
Piston draws in a charge of air at below existing atmospheric pressure through the inlet valve, compresses it to a pressure slightly above the pressure in the engine manifold, and discharges it through the delivery valves into the connecting passage to the engine. Compression is similar to that in the engine cylinder; thus following the general polytropic equation $PV^n = C$, where n is between 1.30 and 1.4 depending on speed, design and local cooling action. The upper value is approximately that of adiabatic compression and is the value for high speed where little time is available to lose heat during compression. At moderate or low speed the value of n drops as heat is lost during compression to the water jacket which surrounds the compressor.	Air enters the inlet and is trapped between the lobe and the casing and is carried around until a compartment opens to the delivery pressure. Back-flow from the delivery pipe then occurs, and the pressure instantaneously raises to the delivery pressure. The impellers are balanced to permit high speed operation. However, the speed is limited by the air inlet condition if practical volumetric efficiencies are to be maintained. Adiabatic compression is used as the ideal compressor and the ratio of adiabatic work to actual work is the type efficiency. For a pressure ratio of 2 the efficiency is about 77 percent; for 4, about 56 percent. The blower is driven from the crankshaft by belt or gear drive. Since a pulsating flow is produced, gears can be a source of trouble.	Power is obtained at the expense of increasing the pumping work of the engine. Ratio of the compressor discharge pressure to the turbine inlet pressure is a function of the compressor efficiency, the turbine efficiency and the ratio of engine exhaust temperature to compressor inlet temperature. A combined efficiency (turbine and compressor) of 0.28 is needed with an engine discharge temperature of 1,400 F to produce a supercharger discharge pressure equal to the turbine inlet pressure. It is difficult to maintain this efficiency over a wide operating range without using variable area turbine nozzles. This characteristic is serious when used with engines that operate over a wide load and speed range. At idle speed practically no energy is available and the turbine runs at low speed.
Advantages		
High compressor—80 percent or better—efficiency if the proper design speed is selected. Normally the compressor is used with a low speed engine at sea level, and where space and weight are of minor importance.	The size for a given air flow is considerably smaller than for a reciprocating compressor. Efficiency at low ratios is fairly good. A large step-up ratio from engine speed is not required.	Small size and light weight for high delivery values. Contains no gears or mechanical drive components, and there are no dubbing surfaces other than bearing that need lubrication.
Limitations		
Compressor has to have a capacity greater than the engine displacement at sea level; and at high altitudes would need capacity about 3 times as large. Thus large size and heavy weight are limiting factors. To reduce the size by increasing compressor speed will result in low efficiency caused by high friction and high throttling losses.	For high pressure ratios the efficiency is poor. Air noise is high because of the interrupted flow at the cut-off point. Accurately machined timing gears are required that become noisy with wear. Matching of the supercharger to engine is critical because of its constant volume characteristics. The ratio of the discharge volume of the blower and the engine flow requirements determine the supercharger pressure produced.	Need for high temperature materials increase the manufacturing costs. It is impossible to achieve good performance over a wide operating range without incorporating special features.

COMPRESSORS

Radial Flow Compressor	Displacement Blower With Compression



Radial Flow Compressor

Displacement Blower with Compressor

Consists of an impeller, that is made to rotate at high speed inside a casting. Air enters the compressor axially at the center. Its velocity is increased by the rotation of the impeller and it leaves radially at the impeller circumference. The air then passes through a diffuser where the kinetic energy is converted into pressure energy.

Compressor is similar to the displacement blower without compression. Air is moved diagonally from one end of the compressor to the other with the aid of a pair of helically lobed rotors that interact to provide an axial as well as a cross seal. Variation of number and proportions of the lobes is possible, but optimum results are attained with a few lobes of large height. Timing gears maintain a correct phase between lobes.

Air is trapped between two radial blades mounted in slotted trunnions in drum. This is mounted eccentrically to the bore of the main casing. Generally, the drum is fitted with 4 blades, which result in 4 delivery impulses per revolution. Such units have rubbing and sliding contacts that must be lubricated at high speed.

Peak efficiencies vary from 60 to 90 per cent depending on unit size and the design pressure ratio. Maximum efficiency can be raised by designing the diffuser to operate in a narrow range. The pressure developed is a function of impeller tip speed and from a size and weight standpoint the smallest possible wheel should be turned at the highest possible speed. However, factors such as wheel stresses must be held to the limit of available materials and the ratio of the inlet annulus to the wheel diameter must be held to certain limits for good efficiencies. Also, shaft speeds must be held to the limits of available bearings. 900 ft/sec tip speeds will produce pressures in excess of 10 psi which are sufficient for low altitude engines.

Air entering one end is trapped within the tooth flanks and is compressed by the interaction of the rotors before being discharged. Amount of internal compression can be controlled by the location of the discharge port. Internal compression results in more efficient operation than is attainable within a blower without compression. Adiabatic efficiency is about 72 percent. Large units delivering 11,000 cfm have given efficiencies of 79 percent at a pressure ratio of 2.0:1. The unit is operated at a speed of 10,000 rpm, which kept the overall size and weight to a minimum.

During rotation of the drum, the volume of the space between blades first increases; and the increasing volume between the blades is filled with air at the suction port. Further rotation results in a reduction of the volume of the space between blades, increasing air pressure approximately adiabatically through some built-in ratio.

Small size and light weight for high delivery values. The discharge pressure remains practically constant with rpm over a wide operating range. Also, good efficiency over a wide pressure ratio range. There are no dubbing surfaces or close clearances to be maintained.

Increased efficiency over units without compression because of internal compression. Freedom from internal friction caused by the absence of metal contact as in the vane type blowers. Lubrication is avoided and the rotors are balanced allowing a high speed of rotation.

No gears are needed and it is relatively quiet in operation because the pressure difference as the ports are open can be kept low. Its adiabatic efficiency, for small displacement units, is relatively high—about 65 to 70 percent.

Large ratio step-up drive is required between engine and impeller speed. The pressure varies as the square of the speed which results in low pressures at low speeds.

High manufacturing costs because of complicated rotor design. Care must be taken in matching blowers of this type to the engine to be sure that over-pressurization does not take place within the unit. Over-pressurization results in performing excess work that lowers the overall operating efficiency.

Lubrication of rubbing parts is required. Lubricating oil reduces the effective octane number of the fuel mixture when used with gasoline engines. Difficulty is experienced with rubbing of the blades against the case if leakage is to be kept to a minimum. Frictional losses increase rapidly with speed. Because of leakage and friction, peak speed is limited to 6,000–7,000 rpm on small units and somewhat lower for large capacities.

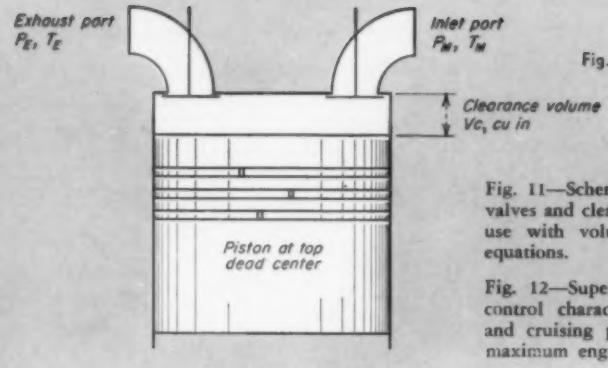


Fig. 11

Fig. 11—Schematic of piston, valves and clearance volume for use with volumetric efficiency equations.

Fig. 12—Supercharger pressure control characteristics for full and cruising power at percent maximum engine speed.

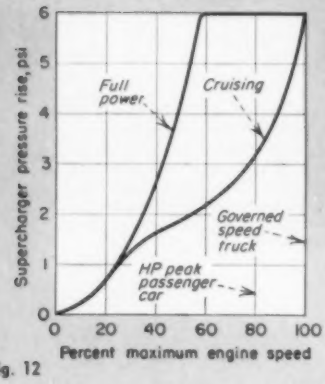


Fig. 12

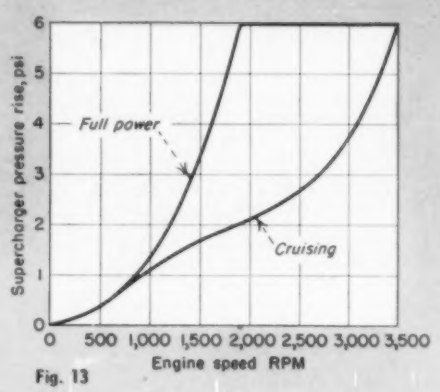


Fig. 13

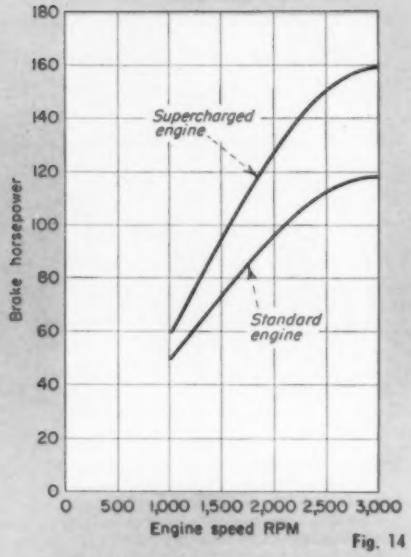


Fig. 14

Fig. 13—Supercharger pressure control characteristics for full and cruising power at various engine speeds.

Fig. 14—Comparative performance for a supercharged and a standard engine at various engine speeds.

P_2, is 21.2 psia from Eq (2). The discharge temperature is obtained from the adiabatic compressor efficiency equation:

$$\nu_c = \frac{T_1(R^{\frac{K-1}{K}} - 1)}{T_2 - T_1} \qquad (4)$$

Substituting:

$$0.56 = \frac{460 + 60(1.445^{\frac{1.4-1}{1.4}} - 1)}{T_2 - (460 + 60)}$$

$$T_2 = 624 - 460 = 164\text{F}$$

Where:

ν_c = adiabatic efficiency
T_1 = inlet temperature to compressor
T_2 = discharge temperature from compressor

The pressure drop through the carburetor must be assumed to determine manifold pressure. The pressure drop will be greater for the supercharged engine because of the higher air flow rate. Therefore, a drop of 1.0 psi will be assumed for the standard engine and 1.5 psi for the supercharged engine. The air temperature entering the engine will be heated to about 100 F—the ambient temperature of the engine compartment. The power increase from the increased manifold conditions can now be found:

$$\frac{bhp_s}{bhp} = \frac{P_s}{P} \times \sqrt{\frac{T}{T_s}} \qquad (5)$$

Where:

bhp_s = brake horsepower of supercharged engine
bhp = brake horsepower of standard engine
P_s = inlet pressure to supercharged engine
P = inlet pressure to standard engine
T_s = inlet temperature to supercharged engine
T = inlet temperature to standard engine

$$\frac{bhp_s}{119} = \frac{21.2 - 1.5}{14.7 - 1} \times \sqrt{\frac{100 + 460}{164 + 460}}$$

$bhp_s = 163$

bhp increase $= 163 - 119$
$= 44$ or 37 per cent

The volumetric efficiency will also be improved by supercharging since the new charge enters at a higher pressure than the exhaust and compresses the clearance volume exhaust gas. The volume of the clearance gas will be reduced from V_c to V_e in the relation

$$V_e = V_c\left(\frac{P_e}{P_m}\right)^{1/k} \qquad (6)$$

Refer to Fig. 11 for meaning of subscripts

This is accompanied with a flow of new charge into the clearance volume to fill up the clearance. This flow will be

$$V = V_c - V_c\left(\frac{P_s}{P_m}\right)^{1/k} \qquad (7)$$

The piston will now proceed on its suction stroke and draw in an additional volume V_s of charge, thus

$$V_T = V_s + V_c 1 - \left(\frac{P_s}{P_m}\right)^{1/k} \qquad (8)$$

but

$$\frac{V_s + V_c}{V_c} = r \text{ compression ratio of engine} \qquad (9)$$

Thus

$$V_c = \frac{V_s}{r - 1} \qquad (10)$$

and, by substitution in Eq (8)

$$V_T = V_s\left\{1+\frac{1}{r-1}\left[1-\left(\frac{P_e}{P_m}\right)^{1/k}\right]\right\} \quad (11)$$

The ratio of the flows for the supercharged and the unsupercharged conditions can be expressed by:

$$\frac{V'}{V} = \frac{V_s\left[1+\frac{1}{r-1}\right]\left[1-\left(\frac{P_e}{P_m'}\right)^{1/k}\right]}{V_s\left[1+\frac{1}{r-1}\right]\left[1-\left(\frac{P_e}{P_m}\right)^{1/k}\right]} \quad (11)$$

Where: prime values are for the supercharged engine

$$= \frac{r-\left(\frac{P_e}{P_m'}\right)^{1/k}}{r-\left(\frac{P_e}{P_m}\right)^{1/k}} \quad (12)$$

Substituting the values for compression ratio and pressures in Eq (12)

$$\frac{6.4-\left(\frac{14.7}{19.7}\right)^{1/1.4}}{6.4\quad\left(\frac{14.7}{13.7}\right)^{1/1.4}} = 1.04$$

In addition to the hp increase caused by improved volumetric efficiency, pumping work is also accomplished by the increased manifold pressure as indicated, Fig. 2, by the area 1-7-6-5.

The hp resulting from the pumping work is:

$$hp_p = \frac{(P_m - P_e)(V_s)\text{ rpm}}{33000 \times 12 \times 2} \quad \text{or} \quad (13)$$

$$hp_p = \frac{(19.7 - 14.7)(330)(3000)}{33000 \times 12 \times 2}$$

$$hp_p = 6.25$$

The total hp increase is:

$$(119)(.37 + .04) + 6.25 = 48.8 + 6.25 = 55.05 \text{ hp}$$

The power to drive the supercharger must be subtracted from the total horsepower. From Fig. 10 it is found that the supercharger power requirements including drive loss to be 14 hp. Therefore the net power gain is:

$$55.1 - 14.0 = 41.1 \text{ hp}$$

Net brake supercharged hp is:

$$119 + 41.1 = 160.1 \text{ hp or 35 per cent}$$

The supercharger drive ratio can be established by computing the drive pulley size based on engine rpm, supercharger rpm and the driven pulley. For the supercharger chosen the effective diameter of the driven pulley can be varied betwen 5.50 and 3.44 in. making possible a variable speed ratio of 1.6:1. A regulator is used to control the drive ratio allowing low ratio driving for part throttle and speed governing at full throttle to prevent over pressurization. The part and full throttle curves are shown in Fig. 12 for a regulated pressure of 6 psi. The engine rpm in terms of the supercharger pressure is established by the drive pulley diameter.

Supercharger speed can be established from Fig. 10 as the rpm required to deliver 1,200 lb/hr air flow at 6 psi. Therefore, if 3,500 engine rpm is assumed to equal the 100 percent point in Fig. 12, the pulley diameter is:

drive pulley x engine rpm = driven pulley x supercharger rpm

$$\text{drive pulley} = \frac{(5.50)(7270)}{3500} = 11.4 \text{ in.} \quad (13)$$

Supercharger pressure in terms of engine rpm and for an 11.4 in. drive pulley is shown in Fig. 13. This curve can be used for calculating the estimated hp gain at engine speeds below the governed speed. Fig. 14 shows the estimated power gain.

Fuel octane requirements for the supercharged engine should be only slightly higher than for the unsupercharged engine. The peak requirement for the unblown engine will occur at a low speed as shown in Fig. 7. Requirements increase at higher speeds and discharge pressures but have little effect on the low speed peak requirement because of the relatively low blower pressure.

Specific fuel consumption at part throttle will be increased because some power is always required to drive the supercharger. Little change occurs during full throttle operation since the compression ratio of the basic engine has not been changed.

Internal combustion engine and supercharger development has progressed to the point where engines are easily capable of developing 50 per cent additional horsepower through supercharging with practically no sacrifice in operating life. This is substantiated by the many normally aspirated engines that are operating with superchargers by making minor changes to carburetion, head gaskets and ignition timing.

Table II—Supercharger Design Requirements

1. **Importance of total engine and supercharger weight.**

   If weight is of paramount importance, the highest possible supercharger pressure should be selected at the expense of cost, part load economy and the use of special fuel.

2. **Operating power and speed range of engine.**

   If the engine is to operate in a narrow speed range, the design problem is relatively simple since practically all supercharged types can be matched to the engine over a small operating range. However, the most difficult engines to supercharge are those that must deliver maximum performance over a wide operating range.

   A curve of the engine air flow and desired manifold pressure vs rpm should be established to be used as a guide in selecting the supercharger characteristics required.

3. **Percentage of operation at part throttle.**

   If the engine runs at part power during a large percentage of its duty cycle, care must be taken to insure that the supercharger does not absorb large amount of power during these periods.

4. **Space requirements.**

   The amount of room available for the supercharger may determine the operating speed and resultant efficiency in order to produce the required air horsepower from a given size unit.

Accumulators for Mobile

Piston type accumulators offer three important advantages for mobile equipment applications: (1) Speeds of operation can be closely controlled and maintained. With present designs built around the variation of engine speeds to regulate pump flow, an accumulator furnishes a constant flow for desired operations; (2) A lower capacity pump is possible in an equivalent accumulator circuit. This not only reduces the horsepower requirements of the system, but also minimizes the heat created by the pumping operation; and (3) The heat created by controlling the flow from an accumulator can be more readily dissipated than that obtained by throttling a larger capacity pump in a conventional system.

FOR COMPARISON, a typical accumulator system and a present-day open center system are shown in Fig. 1(A) and (B)—both the systems being designed for approximately the same operation. Assuming that the cylinders require ½ gal of oil for maximum displacement and desired cycle time is a total of 2 sec, a 2 gal accumulator is necessary. Half of the capacity supplies the oil for two full operations,

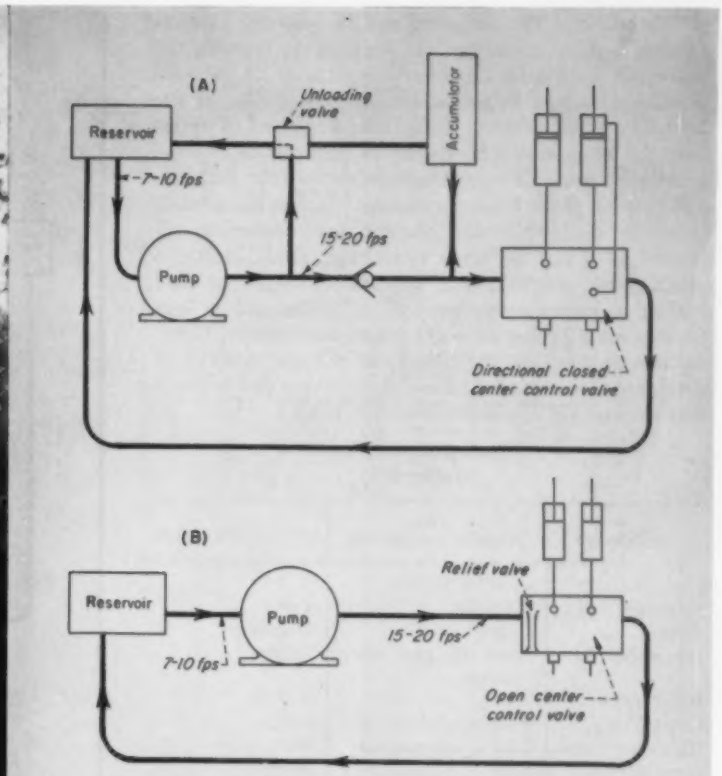


Fig. 1—Typical closed center accumulator system (A) and widely used open center system (B). In the accumulator circuit, oil flows from the reservoir to the pump through the check valve to the accumulator. Maximum pressure on the accumulator opens an unloading valve, the oil then circulating at reduced pressure to the reservoir. At minimum accumulator pressure, unloading valve resets stopping circulation to the reservoir and starts accumulator charging. Oil flow in (B), during the neutral or hold position of the valve, is from the reservoir to the pump to the valve and back to the reservoir at a minimum pressure drop.

Equipment

W. T. STEPHENS
Parker Appliance Company, Cleveland, Ohio

the other half allows sufficient air space to keep the pump pressure at a reasonable level. Thus, a 1-gpm pump can be selected. One minute would be required to charge the accumulator with the overall charging rate one minute out of four. If the maximum operating pressure of the cylinders is approximately 1,000 psi, the accumulator could be charged with nitrogen to give the same pressure. The unloading valve in the circuit could be set to unload to the pump at 2,200 psi and start to recharge the accumulator when the pressure drops to 1,100 psi. This arrangement would then complete the system.

For the same conditions of operation, the open-center system requires a 15 gpm pump. While 900 gph are pumped and the operating cycle is 30 times each hour, only 15 gph is actually used to do any work. During non-operation, the excess oil is bypassed from the pump to the reservoir through a directional open-center valve. This is equivalent to the accumulator circuit.

A component comparison of the two systems is shown in Table I. Cost-wise, there is little difference between the systems. However, the accumulator circuit has the advantage of design simplicity with an increased emphasis on the control of operating speeds.

As a guide in the design of mobile hydraulics, several factors should be considered. In selecting the cylinder, the closer the mechanism can be operated to a 1:1 ratio of cylinder stroke to height of lift, the more efficient the operation. After selecting the cylinder and speed of operation, the pump should be chosen on the basis of cycle of operations, pump drive speeds, together with the pressures and possible shock loads encountered. A directional valve should be used which will give the finest feathering and control so as not to induce unnecessary shock loads. In selecting the reservoir, it is important to have sufficient baffling to keep the maximum oil in motion and to keep the maximum oil flow or rise in the reservoir below 70 fpm. In most applications, the capacity of the reservoir can be determined from this formula: ½ gal + 10 per cent to pump flow + working displacement of the cylinder.

Table I

Components	Accumulator System	Open Center System
Reservoir	1½ gal	4 gal
Pump	1 gpm	15 gpm
Directional Valve	Small 15 gpm closed center	15 gpm
Relief Valve	None	Built in
Check Valve	Built in accumulator	Built in
Unloading Valve	Built in accumulator	None
Accumulator	2 gal	None
Oil Lines	¼ in. except ½ in. from accumulator to valve to reservoir	½ in., ¾ in. return lines

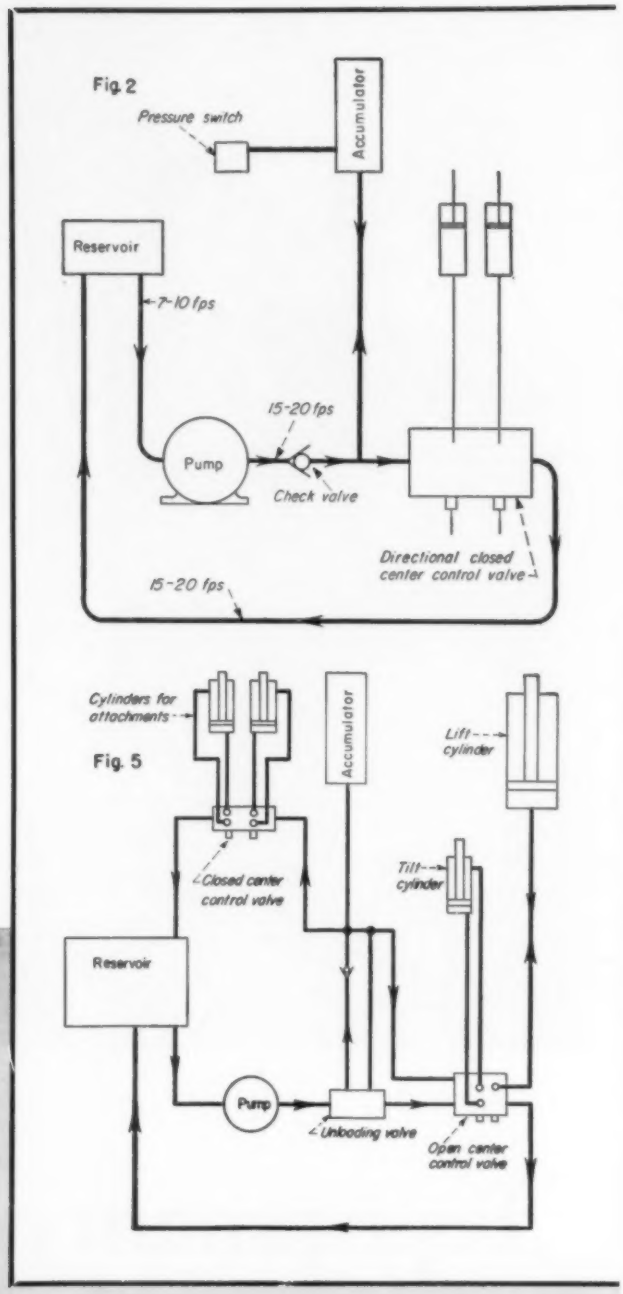
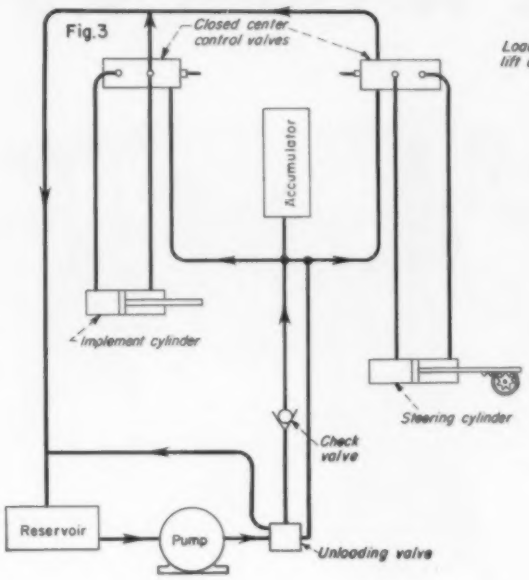


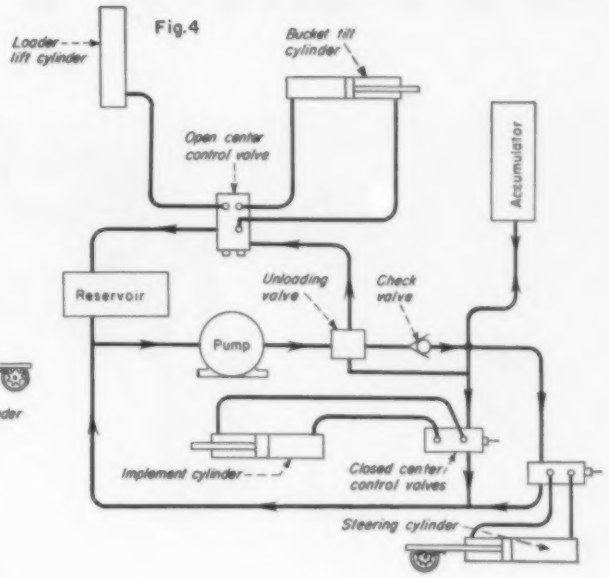
Fig. 2—Electrically actuated closed center accumulator system in which a pressure switch automatically cuts out the pump motor when maximum accumulator oil pressure is reached, cutting it back in at the lower pressure setting. Switch can also be used to operate a solenoid controlled unloading value to return pump flow to the reservoir upon reaching maximum accumulator oil pressure.

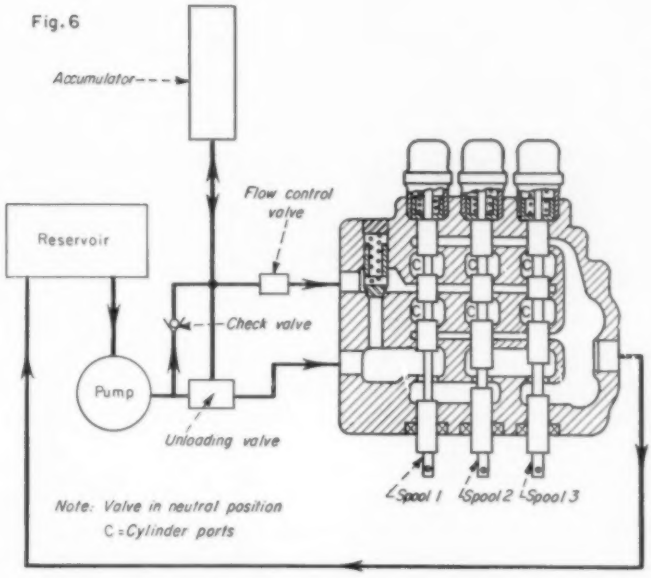
Fig. 3—Future agricultural tractor system designed around a closed center accumulator circuit. Constant accumulator flow maintains good steering and implement control. Since operations are comparatively intermittent, smaller pump and lines enable design economies.

Fig. 4—Another potential agricultural tractor circuit consisting of a semi-closed center accumulator system to operate the implements and steering. With a larger pump used than in Fig. 3, the unloading valve dumps through an open center directional valve to directly operate the front end loader or other larger equipment. This arrangement enables the large volume pump capacity to be used for the heavy operations while maintaining a constant controlled flow to the smaller steering and implement cylinders for close control of speeds.

Fig. 5—A future industrial lift truck circuit using a combination open and closed center accumulator system to compensate for differences in volume and pressure of oil required to lift load and tilt forks. By arranging the open center valve similar to spools 1 and 2 in Fig. 6, spool can be operated to direct only metered accumulator flow to the tilt cylinders. A full single acting open center spool 2 is used to close open center to lift the load, both accumulator and pump flow being utilized. Small closed center valves connected to the accumulator with a return to the reservoir can be used to operate attachments or for steering. Also, because of metered positive accumulator flow, push-button solenoid control of auxiliary valves is possible—emphasizing speed and ease of operation.







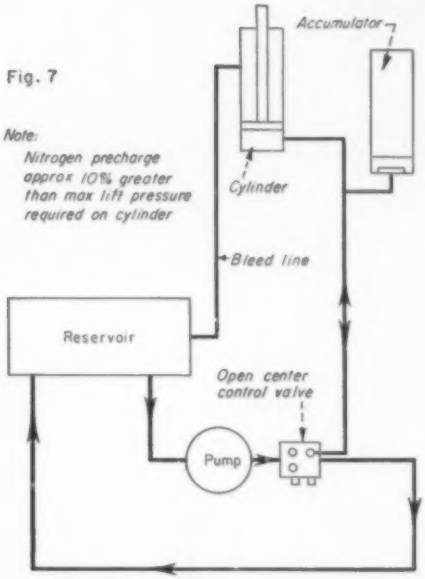
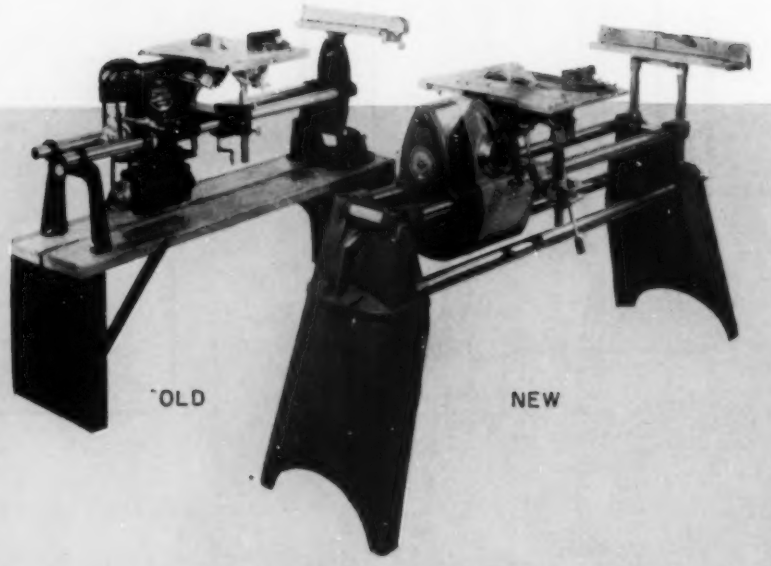


Fig. 6—A possible accumulator system using modified spools in a standard parallel open center directional valve. Spool 1 can be operated without closing open center, metered control being available to the high pressure line between the ports. Spool 2, a conventional double action open center unit, can be operated to close the open center making both the pump and accumulator flow available to the cylinder ports on the spool. Spool 3 can be used to direct the constant accumulator flow for an initial operation while most of the engine power is being used for a simultaneous operation. When engine load is relieved, the spool can be shifted far enough to close open center to allow pump flow to take over.

Fig. 7—Absorbing the shock of stopping a load being lowered is another potential use of an accumulator circuit for mobile equipment. Air charge of the accumulator absorbs the shock and prevents upsetting of the tractor. The piston, seated as shown, seals off any possibility of air leakage past the piston O-ring into the oil circuit when there is less pressure on the oil than on the air side.

Other Product Engineering articles on the application of accumulators include . . . Improve Circuit Performance With Hydraulic Accumulators by H. L. Stewart, October 1952 and Eight Basic Hydraulic Accumulator Circuit Applications by Edward M. Greer, 1953 Annual Handbook.

DESIGN FEATURES



The Shopsmith

An Example of Engineering Ingenuity

Ease of operation, safety and modern appearance are the design goals around which Magna Engineering Corp., Menlo Park, Calif., developed the latest in home woodworking equipment—the Shopsmith Mark 5. Specifically designed for multi-purpose use, the new model combines high quality, universal components in compatible relationships that result in a table saw, lathe, disc sander, horizontal and vertical drill presses.

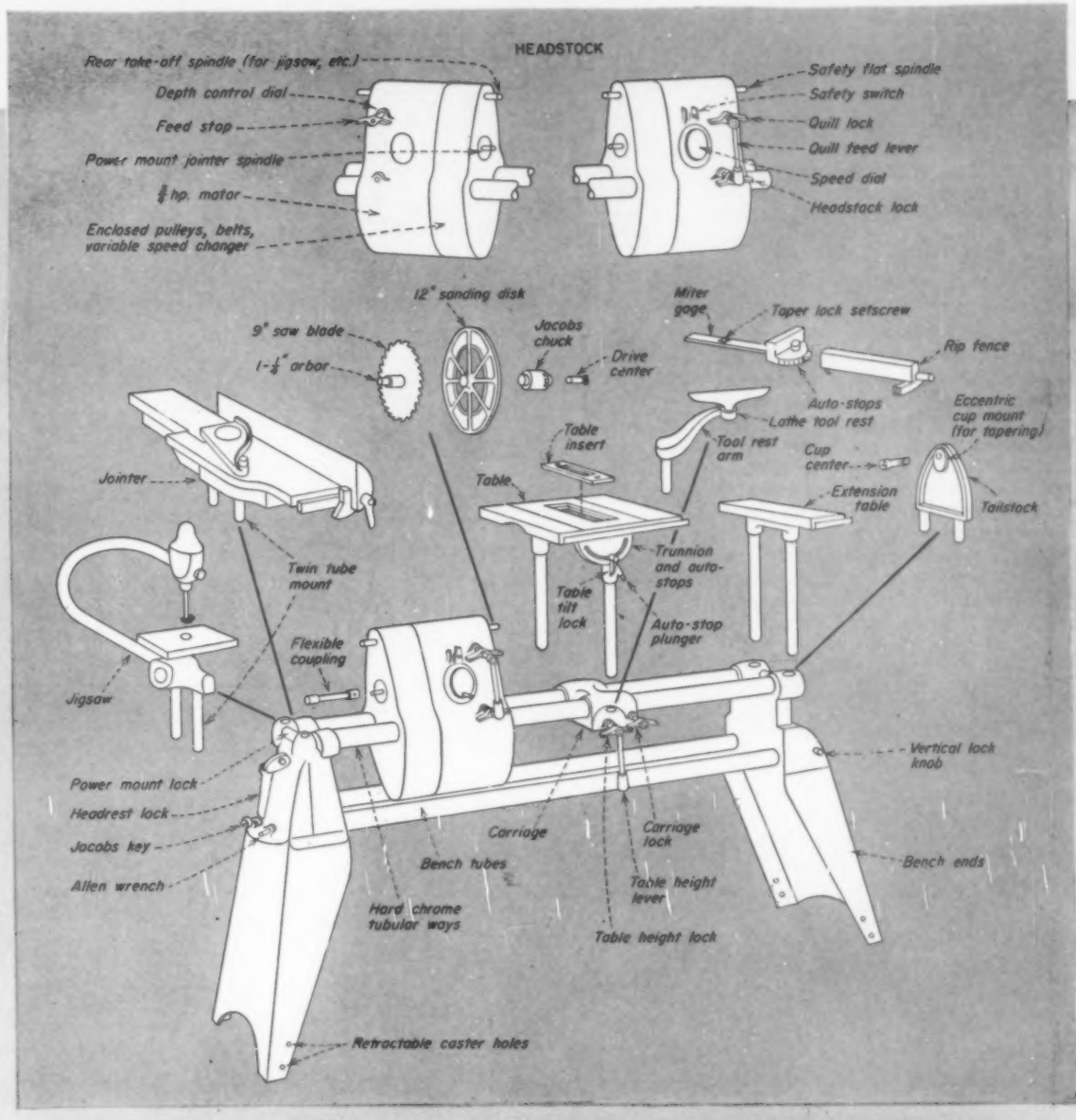
One of the most notable concepts behind the design thinking is the appliance approach to ease of operation. Because of the rapidly growing mass home improvement market, Magna designers came up with a plug-in, ready-to-operate unit having a simple, but efficient variable speed transmission. Believing that it is easier and safer to build skill and accuracy into the machine rather than into the average operator, the engineers went one step further and designed each operation for optimum efficiency. Thus, by simplifying the controls, the margin for error is substantially lowered.

Safety plays an important role throughout the design. All moving parts, except tool spindle tips, are totally enclosed. The on-off switch arrangement is specially designed to prevent accidental turning "on", yet allows a quick shut off. All lock handles are clearly marked to indicate their exact function and are located at the front of the unit.

In appearance, the Shopsmith has a clean, functional look to promote its home acceptance. Typical machinery "bosses" have been eliminated. The two-tone paint with hammer-tone finish blends castings and stampings together into a homogeneous pattern. Handles give a pleasing appearance, combining styling with function. And steel parts are protected against corrosion to maintain the machine's stylish mark.

Versatility and convenience received maximum consideration. Conversion from one operation to another can be accomplished in a fraction of the time formerly required, and two compatible operations can be simultaneously set up for a logical work sequence. Also, since floor space is a definite home limitation, the unit is designed for quick attachment of accessory tools. When not required, the tools can be easily wall-stored out of the way. Retractable casters are another feature which promotes maximum use within a limited space.

IN NEW PRODUCTS

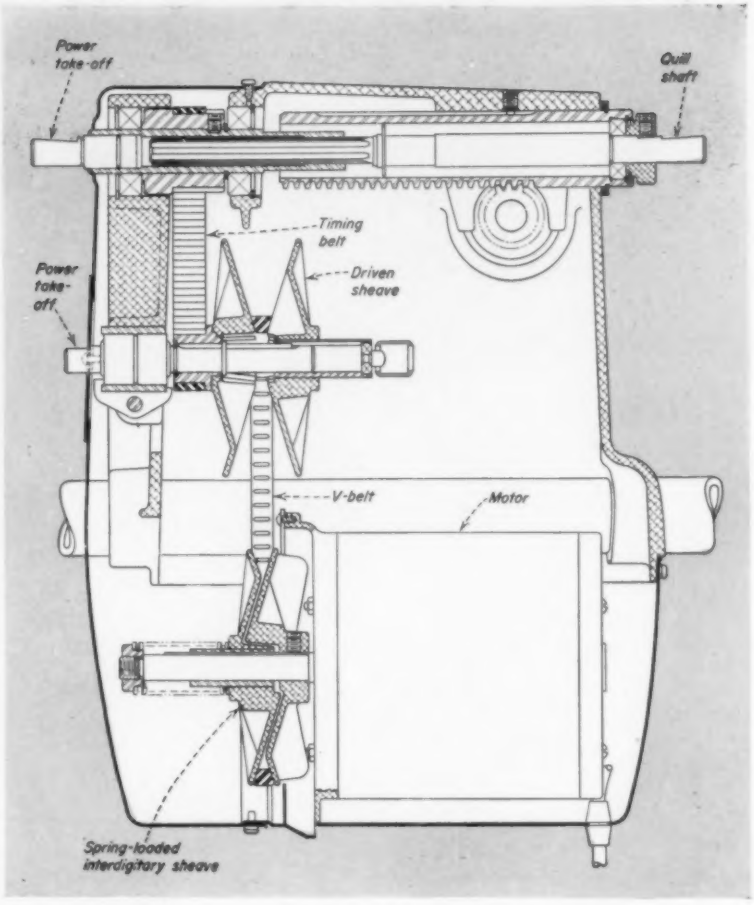


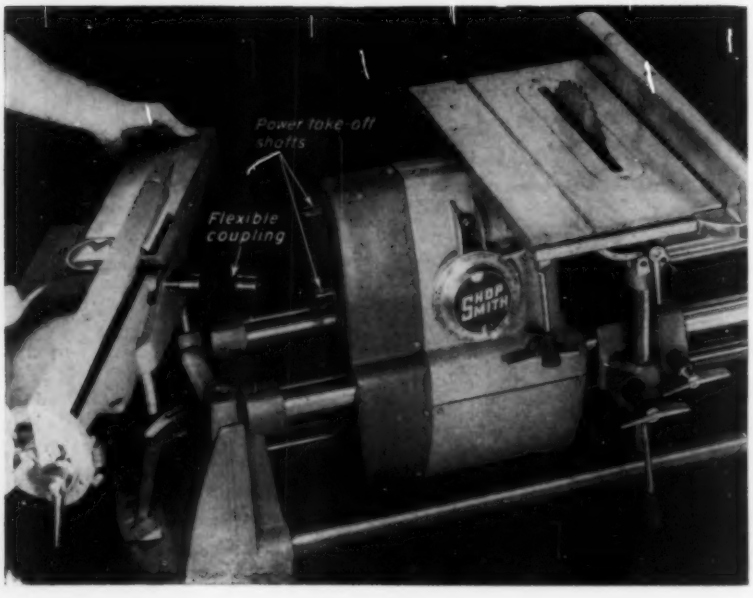
CARRYING the appliance concept of functional appearance, ease of operation and predictable performance throughout, the new Shopsmith represents the latest in engineering thinking. Compared to the older model, it weighs 30 percent less, has fewer parts, and costs a little less—yet features improvements in almost every phase of product design. Basic design principle of the new unit is non-duplication of parts. Because of this concept, all the major components are made as integral parts of the basic machine, compatible and complimentary in their relationships. With the design built around headstock, motor, frame, table, and quill and spindle assembly, accessory components are designed to give a series of effective single-purpose tools, each independent of the other. A variable speed power mount for accessories further emphasizes this concept. (*continued on next page*)

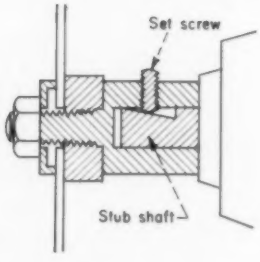
POWER TRANSMISSION:

optimum operating conditions, ease of use and safety required an enclosed variable speed drive.

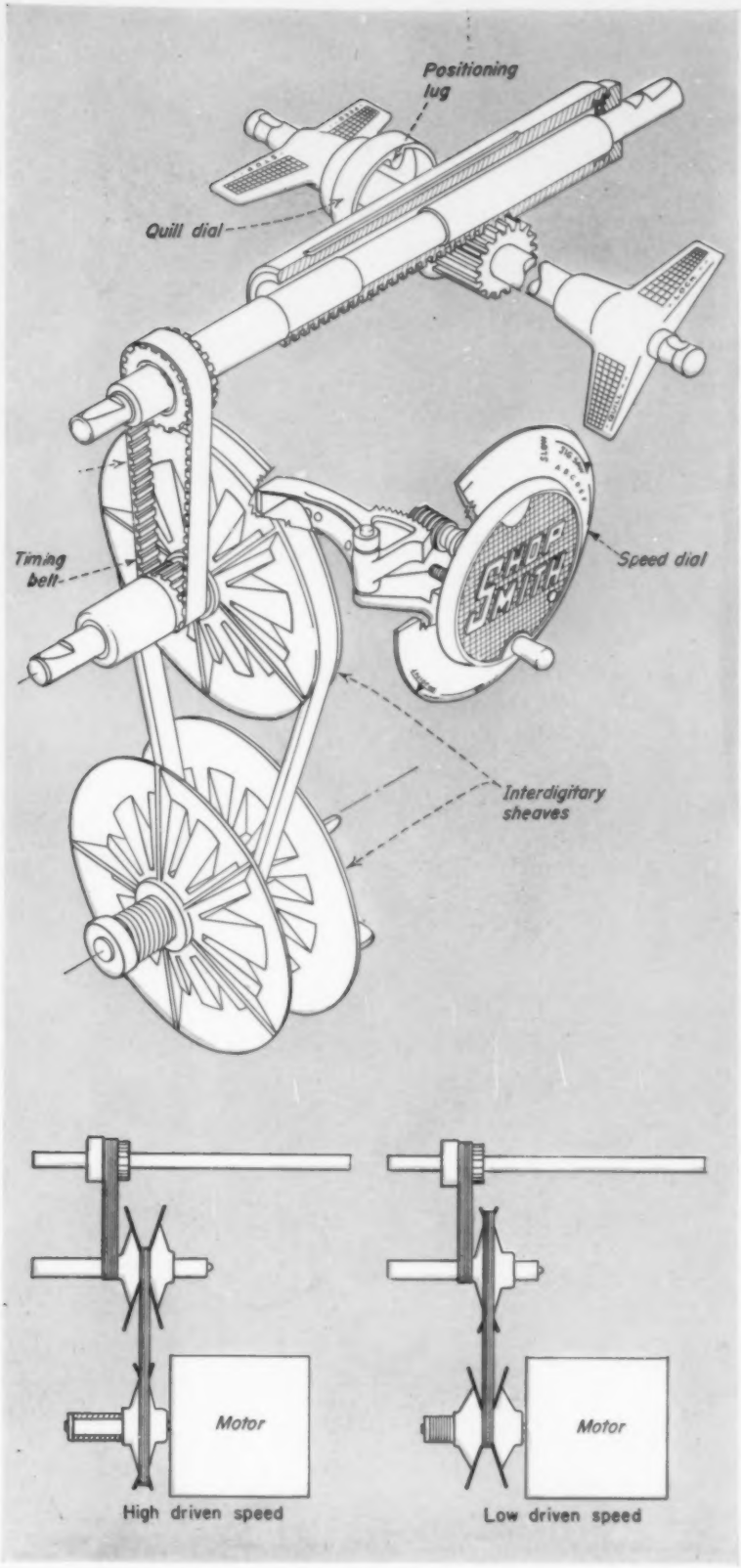
SCHEMATIC of the variable speed transmission and cross-section view of the actual machine installation. Speed control is obtained by rotation of an externally mounted indicator dial which, through a worm and quadrant, positively displaces a driven interdigitary sheave. The tooth belt fixed ratio drive gives the best balance between speed and torque for the different operations. Quill shaft penetration is based on the rotation of a depth selector dial to position an integral stop lug corresponding to the depth desired. Quill feed is by rack and pinion arrangement, and is spring loaded for automatic return. Because of the various interrelated operating components, manufacturing tolerances are held within limits as close as 0.0002 in to insure built-in precision and repititive accuracy.

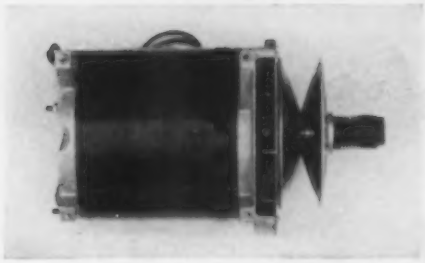






EXTENDING the spindle shafts through the rear of the drive housing gives a ready means for mounting of jointer and jig saw. Stub shafts are of different lengths to assure correct connection of accessories to the drive, otherwise flexible coupling cannot reach. Also note tapered flats on shaft ends shown in insert view. By this design, tools can be secured to shaft by single set screw without possibility of tool "walking" off shaft because of vibration or loosening of screw.





USE OF CARTRIDGE motor illustrates one example of reducing costs to offset added expense for other features. Motor is purchased without conventional frame and is mounted to formed steel cover inside of drive housing. Besides lower cost benefit, this arrangement results in space and weight savings in entire drive assembly design.

CONTROLS:

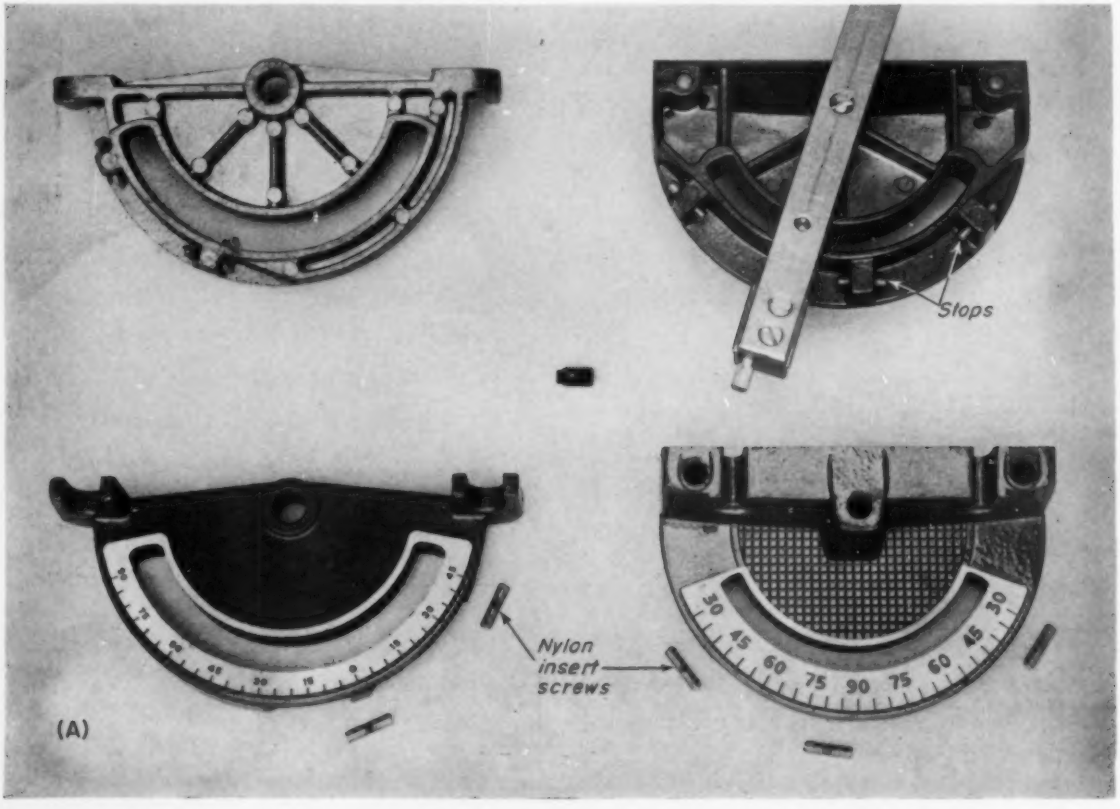
design points up emphasis on built-in accuracy, less on operator judgment.

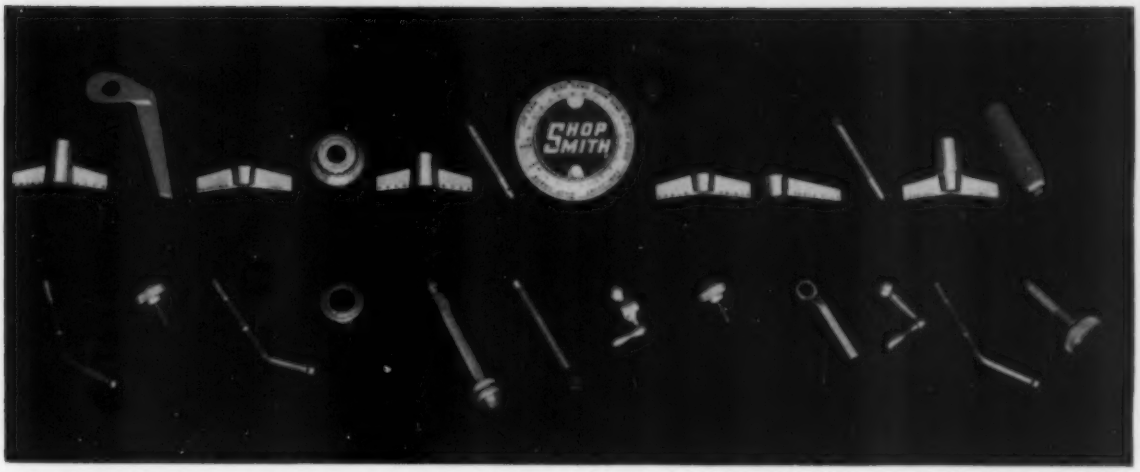
PROPER SPEED selection for the sawing, sanding, routing and drilling operations is clearly labeled on a functionally designed dial. To prevent unintentional high speed operation, an automatic spring stop engages the dial at 3,400 rpm position. Spring must be manually depressed to enter the 3,400-5,200 speed range. The "on-off" switch is recessed between flanges cast integrally with the headstock to prevent accidental turning on of the machine. In the off position, the switch is entirely within the radius of the flange. In the 'on' position, the switch projects sufficiently to allow quick turn-off during operation. (*continued on next page*)

CONTROLLED depth drilling is designed around dial to select depth desired in increments of a $\frac{1}{16}$ in. Quill lock is used to hold the quill in an extended position.

BUILT-IN TAPER control consists of a calibrated eccentric mount locked in place by a single set screw. Cup mount is calibrated in $\frac{1}{16}$ in., range being from 0 to $\frac{1}{2}$ in., to permit accurate off-setting of the cup center for turning tapers.

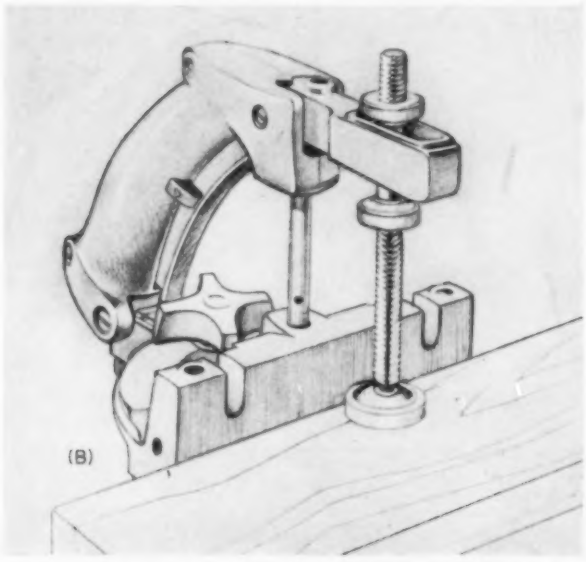
FASTENING AND LOCKING: *for ease of operation and adjust-*





COMPARISON of new and old model locking handles and dial controls illustrates the design emphasis on functional styling in new machine. All handles are of the quick-acting "butterfly" type, each engraved to describe its function. For handle finish, an extensive survey indicated that for reasons of durability and quality, a Rollbright finish was most satisfactory for this operation. Product development considered plating, painting and polishing.

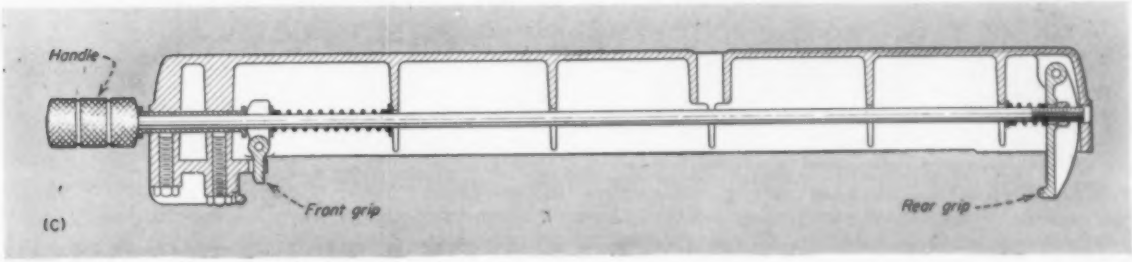
ment, simplicity of design.

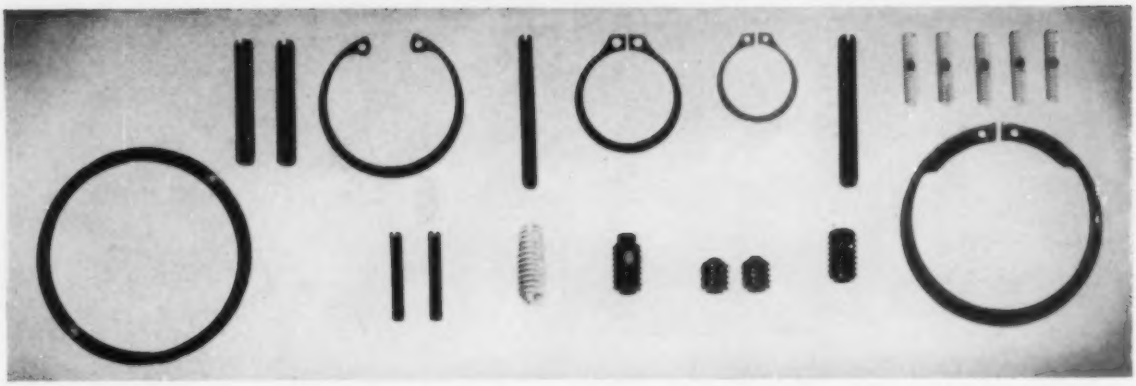


(A) MITER GAGE and trunnion feature use of nylon insert screws for adjustable automatic stops. Selection of these screws over conventional set screws eliminates possibility of loosening because of vibration and facilitates settings both at the factory and owner levels.

(B) PISTOL GRIP CLAMP marks its first use in wood working equipment, and is a big step forward to make work feeding operations safer. By adjusting the stop nuts on the holding screw, the operator can readily obtain the desired holding pressure on the work while cross-cutting or mitering.

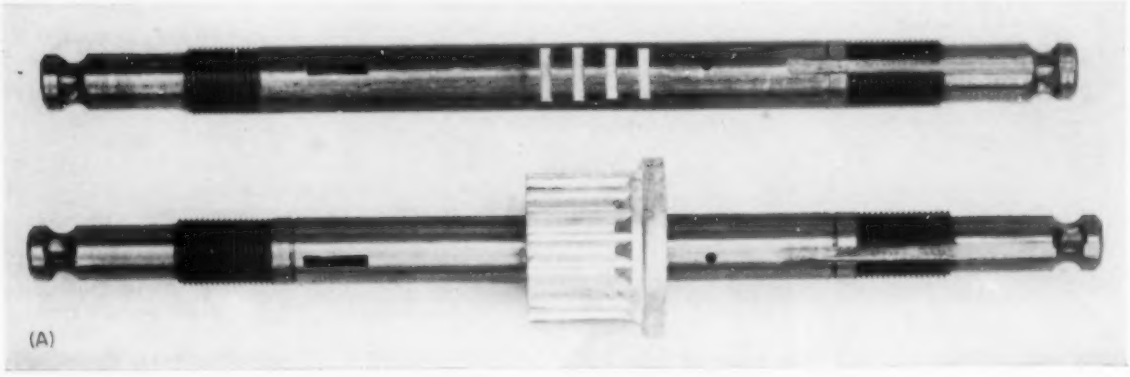
(C) TABLE FENCE has been redesigned for a single knob, front-tightening operation. Turning the lock handle automatically squares the fence to the table, the front grip engaging the bottom of the table first and the rear grip last. (*continued on next page*)





WITH EMPHASIS on designing for simplicity of readjustment, new machine contains many such fittings as snap rings, nylon insert screws, roll-pins and socket-head screws. For maximum owner convenience, all sockets are the same size, although screw sizes themselves vary. Another primary reason for selecting these simple but effective types of fasteners is to permit uninterrupted operations without possibility of fasteners loosening and thus destroying the settings. Also, adjustments can be quickly and positively made at either factory or owner levels.

PRODUCTION: *some techniques employed to reduce costs while main-*



MATERIALS: *light alloys and modern techniques combined to mini-*

PERMANENT MOLD aluminum castings replace many sections formerly made of cast iron and steel stampings, also combine components into integral assemblies. Because of integrated design of many components, new unit has less parts, is significantly lighter and features improvements without increasing cost over older model.

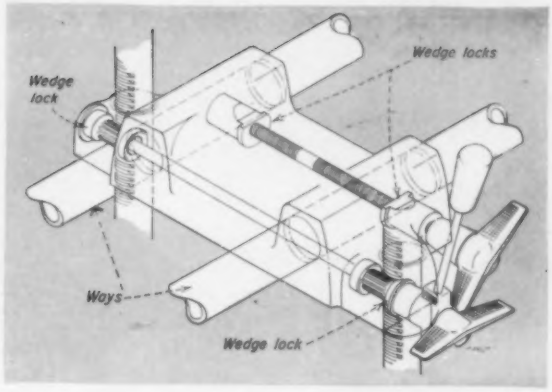
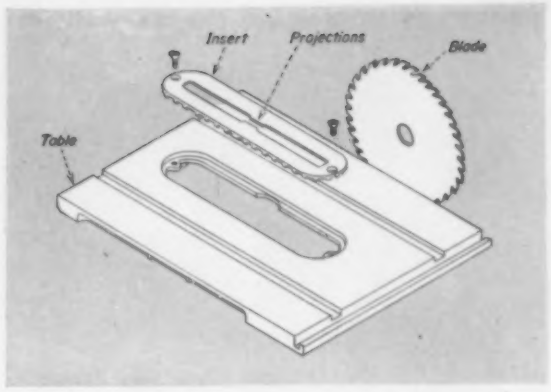
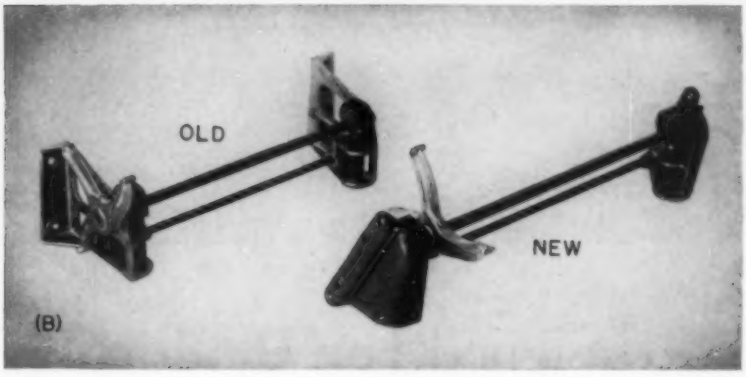


TABLE AND CARRIAGE LOCK MECHANISMS points up use of simple double wedging action for mechanically locking and unlocking. Slight rotation of the handles causes the wedge contoured blocks to move towards each other; thereby wedging themselves against the tubular ways.



TO INSURE flush fitting of table inserts without the use of leveling screws, inserts are made slightly bowed and coined with a special studded bottom rim which allows piece to automatically seat flush. Also, saw blade insert has integral center projections to prevent blade damage.

taining or improving quality.

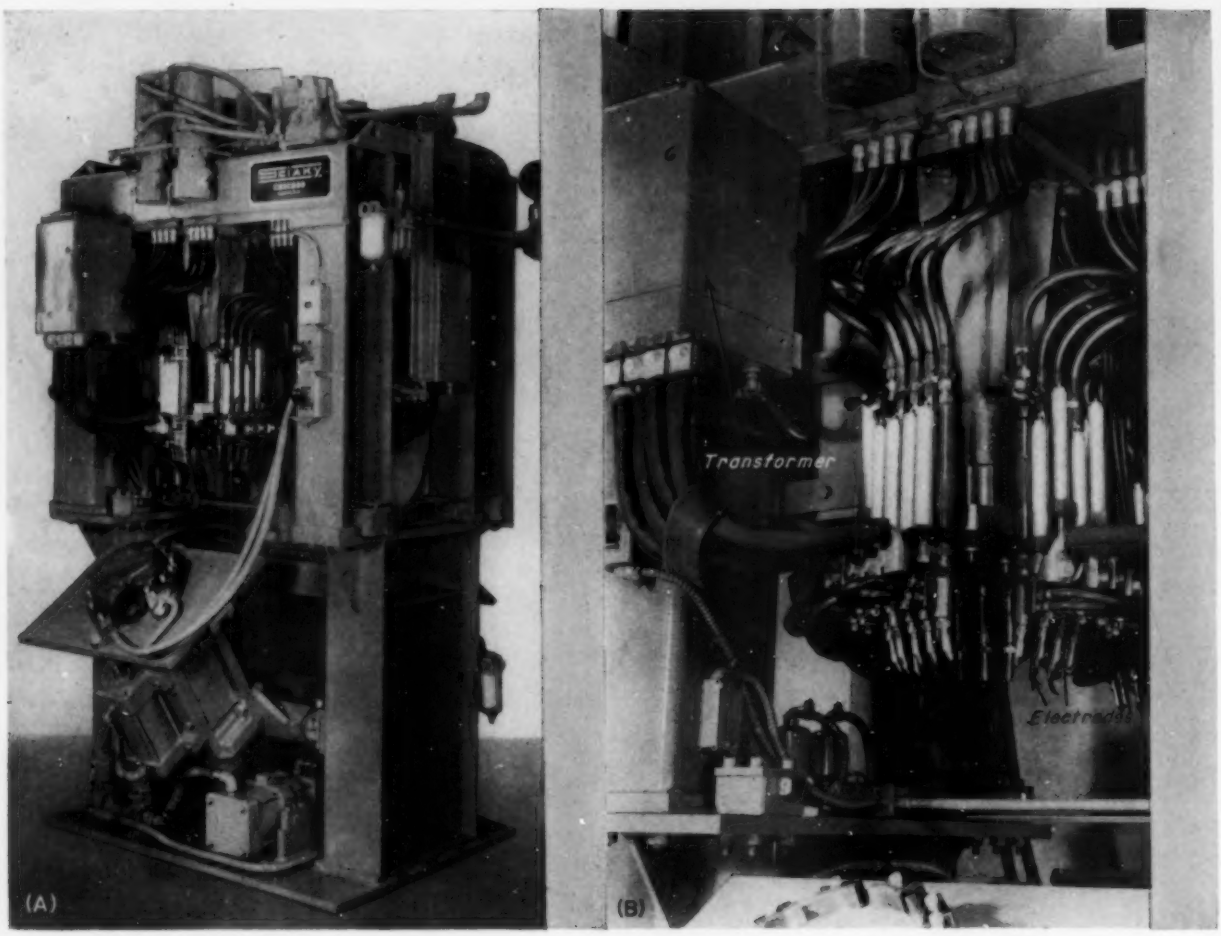


(A) PINION SHAFT assembly consists of screw machine part with pinion gear cast in place. Flats initially milled into the shaft prevent the gear from moving horizontally or radially.

(B) RETRACTABLE CASTERS permit firm base for operation with mobility. Assembly was redesigned to combine styling with added support for caster mechanism. While using same principle of a continuous cam, new assembly replaces cast supports with formed sheet steel sections, saving $.36 on each machine.

mize weight, reduce number of parts, and lower machining costs.

POWDER METAL PARTS find extensive use throughout new design. Included are such items as the split cam to permit adjustment of belt tension, timing belt drive gears, continuous cams for the caster mechanism, table raising and locking gears, keyed sleeves cast into the drive sheaves and ribbed unit used in table raising assembly.

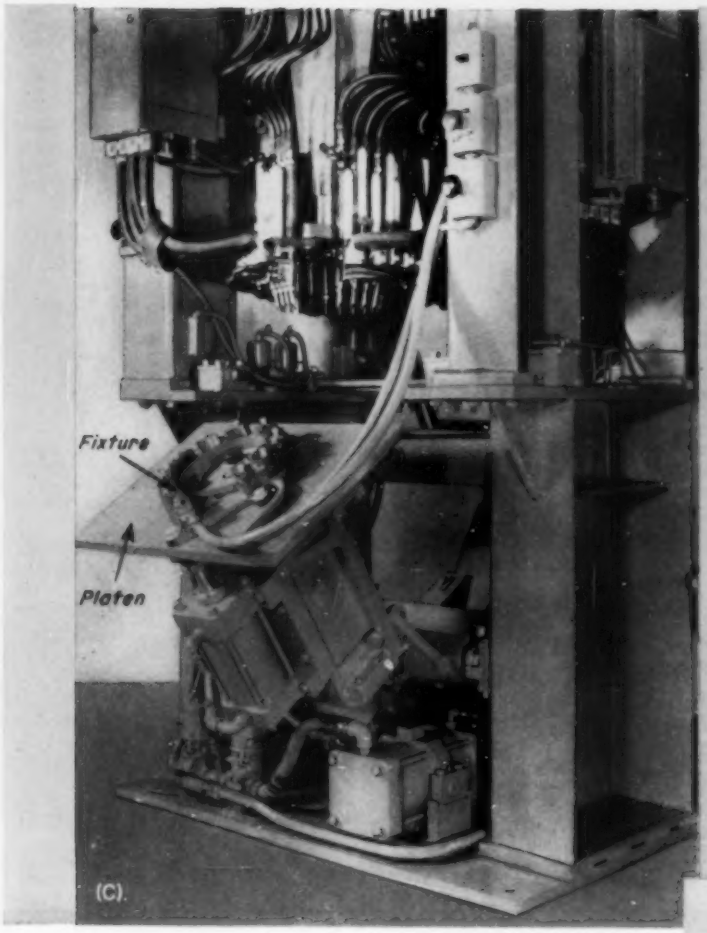


Welder Designed for Production

By designing their new multiple-electrode spot welding machine to consist of a standard base, a specially designed fabricated superstructure and interchangeable packaged welding components, Sciaky Bros., Inc., Chicago, Ill., has developed a standard unit with wide flexibility for different welding operations. Each packaged unit—a transformer with many secondaries, a hydraulic booster and multiple hydraulic cylinder electrode holders—is a welding machine in itself. Thus, by positioning the units on the superstructure to conform to the design of the part to be welded, a versatile production machine is easily obtained. Changing from one electrode configuration to another merely involves removal or relocation of individual packages, the basic machine remaining unchanged.

Heretofore, most metal fabricators relied on welding units specially designed for the operation. When the design changed, modification of the equipment usually precluded the most economical production. In many applications, it became more feasible to scrap the original machine than to rebuild for the new operation. It was for this reason that the new machine was designed—to give fabricators a basic piece of production equipment which allows the major portion of the original expense to be salvaged when changing to a different welding application.

Provision is made throughout the design to permit easy removal of all operating components, and for quick rearrangement of elements for a new welding configuration. Controls are made as simple as possible to allow the user to restrict or increase the number of welding functions. Space is allowed in the control cabinet for the



(A) Versatility for a large number of resistance welding operations is the design objective behind the development of Sciaky Bros., Inc. SX-36G welding machine. By adopting the "packaged" concept of design, the machine can be easily modified for different applications without expensive or time-consuming alterations formerly accepted as standard practice in this field.

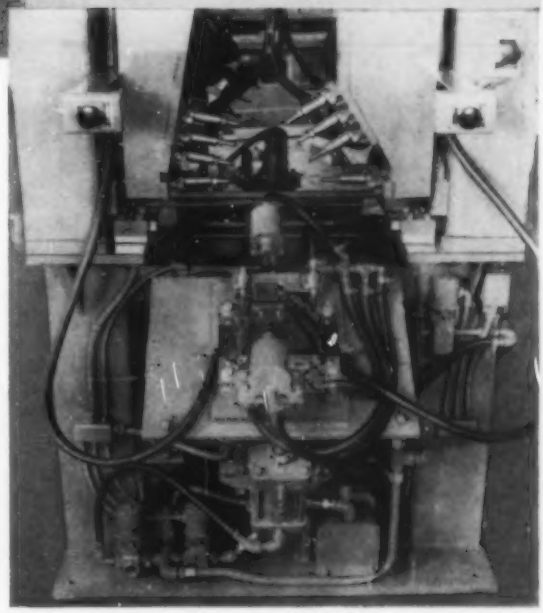
(B) Close-up of the electrode holders illustrates the simple positioning of the guns within the superstructure framework. Individual guns are single acting water-hydraulic units with spring return. Depending on the amount of power available, the guns are fired either simultaneously or in cascade which is by groups tied into respective transformers.

(C) For ease in loading and unloading work and to increase production, two independent platen units, at the front and back of the machine, automatically swing in and lift to the welding position and after the welding sequence, swing out for unloading. For simplicity of adjustment, the plate holding the fixture for the part to be welded can be easily removed as an assembly.

Versatility

addition of relays and timers for extra packaged units, and push-button operation is provided to quickly remove unwanted units from the working circuit.

Transformers used with these units are designed with 1 through 5 secondaries and vary in capacity from 10 to 100 kva, depending on the number of guns or hydraulic electrode holders required. Since water is necessary for the water cooling of the secondaries, the same water is used for the hydraulic medium. Also, since compressed air is another common item used by modern welding machines, the packaged units make use of the same feature. The air is transmitted to the boosters where it is converted into hydraulic pressures up to 1,000 psi. This simplifies the hydraulic system and permits significant cost savings when re-arranging the welder components for a new production design.



ILLUSTRATING the adaptability of the machine for different operations note the difference in electrode position and the modifications to the platen work holding fixture compared to those in prior views.

Engine-Mounted Power-Pack for Mobile Equipment

Representing more of a new concept in mobile equipment applications than a development in electrical power design, the Electrall unit recently announced by International Harvester Co., makes power available for purposes and places for which it is now seldom or readily accessible.

Specially designed for I-H by General Electric Co., the unit is completely self-contained in that it contains the generator, exciter, overload protection and outlets for the three types of power receptacles most commonly found on farm equipment and in the home.

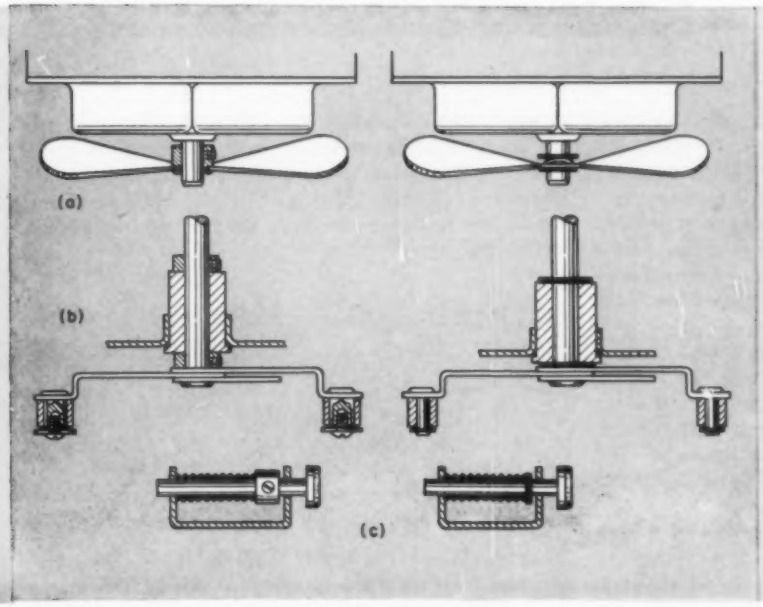
Power-wise, the generator can supply sufficient power for standard 220 v, 3 phase, 60 cycle a-c equipment. It can also supply the 120 v, single phase load in ordinary household wiring circuits as well as the heavy load single phase circuit requirements of certain appliances. At starting, the generator can handle momentary loads up to 200 percent of normal capacity.

THE GENERATOR UNIT, an a-c synchronous power pack, is mounted on the side of the engine block and is driven through a simple gearing and V-belt arrangement. A single control points up the ease and convenience of operation. Future uses will feature extensive multi-motoring on auxiliary equipment.

Retaining Rings Simplify Recorder Design

With increasing attention on present day production costs, designers are continually searching for components and assembly techniques that will spell out gains in reduced manufacturing costs and compactness of design. An example of this is a new portable tape recorder recently developed by Telectrosonic Corp., Long Island City, N. Y. in which extensive use of Waldes Truarc retaining rings was made to replace bulkier and more expensive fastening devices. Not only were significant savings realized in replacing other types of fasteners, but use of the rings pointed the way for a smaller, lighter assembly.

PORTENDING the future not only in farm equipment but also for many industrial applications, the engine mounted self-contained generator unit makes the prime mover a mobile source of electrical as well as mechanical power. In this illustration, the unit is mounted on a wheel tractor and supplies power to an accompanying motor unit on a hay baler. Other applications are similarly designed.



THREE EXAMPLES of retaining rings to replace more expensive fasteners: (a) Hub was formerly staked to the fan and secured to shaft by a set screw. Assembly was simplified by using two grip rings in combination with a spring-type bowed washer. Rings also serve as a safety clutch for fan. (b) Two collars and set screws were used to secure shaft in bearing. Two retaining rings replace collar and screws with machining eliminated. (c) Before collar and set screw secured pressure bar and spring to the frame. Now, one grip ring replaces both and permits a smaller subassembly.

How to Prepare

Technical Reports

A guide to the selection of the appropriate format and the mechanical make-up with an analytical approach to the preparation and writing of the technical report.

H. A. CAMPBELL
Chief of Engineering Laboratories
Bell Aircraft Corp., Buffalo, N. Y.

Classification of Types of Reports....

- **Receiving and Inspection**

To verify that purchased materials and equipment conform to purchase order specifications. Also used for production inspection and travelers. USE STANDARD COMPANY PRINTED FORMS

- **Performance of Purchased Items**

To measure performance and anticipate troubles; to judge suitability of machine or material for service intended; for environmental testing.

- **Tests of Current Designs**

To observe correlation between design and performance; to improve design techniques and methods.

- **Investigations of Materials, Processes**

To determine properties of materials, processes and methods required to produce desired finished parts.

- **Investigations of Troubles, Failures**

To determine cause of trouble and failures of service parts; to recommend remedial and preventive actions.

- **Proposals to Apply Research**

To determine if new knowledge and techniques can be profitably applied.

- **Literature Review**

To estimate extent and validity of knowledge in particular field or technical interest in which first-hand work is not feasible.

- **Progress Reports**

To inform associates, interested engineering groups and higher authority about the status of a particular project.

- **Administrative and Special Purpose Reports**

Depends on initiating party, and under what circumstances—relative to current conditions and subject matter.

WITH THE GROWING COMPLEXITY of business organizations and the increasing emphasis on the decentralized concept of management control, the technical report is taking on new importance as the basis for many of management's policy making decisions. For management to rely upon the report as a primary information link between it and remotely-controlled engineering activities, the material presented must be reliable, accurate and complete. Of equal importance, it must be readable.

There is no one 'best' form for all reports. The subject matter, objective desired, who gets the report and the circumstances of its presentation all influence the final form in which the report is prepared. But regardless of the form selected, the essential facts must be presented in a way that will command attention, carry conviction to the reader and induce action where appropriate.

Above is a suggested guide to the selection of the report format which best fits the set of conditions surrounding the need for the report. By carefully reviewing the category in which the report requirement falls and then determining which set of conditions the subject-matter most closely meets, the proper format can be easily established. While the format indicated represents, at best, a compromise selection, it serves primarily as a guide to the over-all context of the report.

PREPARING THE REPORT

Most difficulties encountered in the preparation of the report, besides the inability of the writer to express his thoughts clearly, can be traced to a lack of understanding of the basic objectives and subject matter. To minimize such difficulties, the actual writing of the report should be preceded by a preparation phase, an analysis of what constitutes the premises upon which a report is based.

Analysis. Whether a report originates as a contract requirement, customer request, proposal initiation or is self-

Which Set of Conditions Does Subject Matter Best Meet?....

(1) Yes-No or go-no-go answer.
(2) Applies only to 1 or 2 projects, models or contracts.
(3) Has no value after project is completed.
(4) Confirmation of a verbal report.
(5) Applies only to a particular or unique device or lot of material.

(1) Subject matter is of engineering importance which is to be submitted to customers or vendors.
(2) Involves extensive equipment or material tests of a semi-permanent or permanent value.
(3) Includes comprehensive progress reports and data.
(4) Contains short analyses or engineering studies on materials. Investigations useful to several projects.

(1) Is of permanent value to most contracts.
(2) Includes analyses and evaluations of types or classes.
(3) Is a research-type work or investigation.
(4) Intended to serve as a long-time basic or working reference.
(5) Is a comprehensive survey or compendium of information on a single subject or group of related subjects.

Then Use . . .

Memorandum

(1) Use memo paper, 6 carbons maximum. Over 6 copies, use ditto.
(2) No cover
(3) 4 pp max text
(4) 2 pp max graphs
(5) 2 pp max photos
(6) Lab group number or correspondence code number
(7) Signed by writer, Group and assistant Group Engineers.

Informal Report

(1) Ditto and sometimes memo and carbons.
(2) Paper or manila cover.
(3) Unlimited pages
(4) Unlimited graphs
(5) Unlimited photos
(6) Issued report number
(7) Signed by writer, Group and Assistant Group Engineer, Chief of Laboratories.

Formal Report

(1) Vellum
(2) Blue board cover
(3) Unlimited pages
(4) Unlimited graphs
(5) Unlimited photos
(6) Issued report number
(7) Signed by writer, Group and Assistant Group Engineer, Chief of Laboratories.

initiated, the first step is to recognize the problem correctly. Once the need for a report has been acknowledged, the probable expense entailed should be compared to the work proposed to solve the problem. This, in turn, often leads to the particular approach used—an analytical treatment, literature review, experiment or test, only one or possibly part of each.

Plans. Next step is to outline in moderate detail, in the form of an operations sheet, the course of action to be taken by all parties involved in the report. A decision should be made as to what is to be done and when, using the preliminary schedule to insure that the necessary materials, people and equipment are assembled together at the time needed.

Planned Action. Following the general plans as to the action required, a preliminary outline of the report should be made to aid in deciding the form of data records and scope of observations needed. By recording all essential information in a notebook, indexed for quick reference, the data can be arranged to eliminate any rewrite before handling the material over for typing.

Evaluation. Analyze results against the problem and what was originally decided as required for its solution. If the problem was not solved, determine the reason, rechecking the analysis and then taking corrective steps.

WRITING THE REPORT

All engineering reports, in whatever form, should meet the following general requirements:

1. Be easily readable, clear and unambiguous; in expression, as concise as possible without being curt or brusque. Critical comment by sarcasm or irony should be avoided.

2. Use standard terminologies and symbols as adopted by the NACA, ASME, AIEE, AIME, ASTM, ACS, Inst.

Table I—Generalized Report Outline

1. *Title page* gives a descriptive title of the report, its origin, by whom it was written, appropriate work order or authorization numbers. Also lists persons to whom copies of the report should be sent.

2. *Table of Contents* shows the major and minor division and subdivision headings of the report. A list of the tables, illustrations and back-cover enclosures, if used, should be included.

3. *Introduction* contains the identification of the subject, nature and origin of the problem, the objectives and the relation of the problem to other subjects.

4. *Results and Recommendations* consists of the answers to the questions raised in the introduction on the objectives of the test or investigation. Main essentials should be summarized and expressed without detail data. Recommendations should be listed in separate paragraphs.

5. *Literature Review* depends upon the nature of the test or investigation being made. Representative material should be carefully cross-checked to see how closely it agrees. If a wide divergence appears, it may be necessary to run independent tests. If literature reviews are used, data should be correlated and carefully presented in report.

6. *Theoretical Analysis* should only be used when actually needed as an integral portion of the report. This section includes reference to the particular symbols used in the report and definitions if necessary. Also, any discussion of analytical results should be placed in this section.

7. *Apparatus and Methods* includes reference to the specific standards used that describe the specifications under which any tests or investigations were performed. If a special setup was used, describe it fully to permit reproduction by other investigations. Use sketches and photographs to a maximum.

8. *Data and Discussion* should support the results shown, under the service conditions and test requirements. If unusual troubles were encountered with the equipment, describe them clearly. If causes were recognized and corrections made, list them in detail. Should more than arithmetical methods of data reduction be called for, show in an appendix a breakdown of the methods of reduction and computation.

9. *Acknowledgements* list the help received in the test set-up, operation of the equipment, advice, data reduction, analysis or any other aid or suggestions that contributed to the preparation of the report. Indicate names and titles.

10. *References and Bibliography* should contain a serial-numbered list of reports, documents, papers, books or other publications to which reference is made in the report. Show serial numbers in parentheses at points in the report where the reference is used. List all literature reviewed. Also include a list of publications related to the subject which might be of interest to the reader. Bibliographies should not be used except as an appendix for a record, or other purpose.

11. *Tabular data, Charts, Curves and Photographs.* Data should be presented as numbered and captioned tables with clear headings and units. Tables of ½ page or less can be included in the text, others on separate pages. Charts and curves should be identified by figure numbers and captioned clearly. If they contain information applicable to their subjects, should be given different serial numbers and indexed in the office index of curves and charts. Place negative number on all photographs and refer to photograph by figure number. Photomicrographs should have specimen marked on their faces.

12. *Appendix* should contain all mathematical derivations, proofs, reference material, material for permanent record and extended discussion of special points noted in the report.

Table II—Outlines for Four Dissimilar Subjects

SAMPLE 1

DAMPING CHARACTERISTICS OF DASHPOTS

J B Peterson

NACA, TN No. 830, Oct. 1941

* * *

13pp + 6 figures, 2 tables, 2 references, 29 equations

* * *

SUMMARY

INTRODUCTION

THEORETICAL ANALYSIS
- Case 1 defined
- Case 2 defined
- Case 3 defined

EXPERIMENTAL INVESTIGATION

CYLINDERS AND PISTONS

MEASUREMENT OF CYLINDER AND PISTON DIAMETER

DAMPING LIQUIDS

COAXIAL OR ECCENTRIC PISTON

RESULTS OF TESTS

DISCUSSION

REFERENCES, Tables, Figures

SAMPLE 2

EFFICIENCY TESTS OF A TYPE B-2 TURBINE WITH AIR AS THE DRIVING FLUID

DS Gabriel & LR Carman

NACA, No. E5C30, April 1945

7pp + 7 figures, 5 equations

SUMMARY

INTRODUCTION

APPARATUS AND METHOD

SYMBOLS

METHOD OF CALCULATION

RESULTS AND DISCUSSION

SUMMARY OF RESULTS

Figures (including curves)

SAMPLE 3

AN ANALYTICAL METHOD OF ESTIMATING TURBINE PERFORMANCE

FD Kochendorfer & JC Nettles

NACA, Research Memorandum No. E8116 December, 1948

46pp, 13 figures, 2 tables, 6 references 40 equations

* * *

SUMMARY

INTRODUCTION

SYMBOLS

ANALYSIS
- Statement of Problem
- Outline of Method
- Assumptions
  - Blading Losses
  - Turning Angles
- Turbine Analysis
  - Stator
  - Rotor
  - Performance Parameters

TYPICAL EXAMPLE OF METHOD

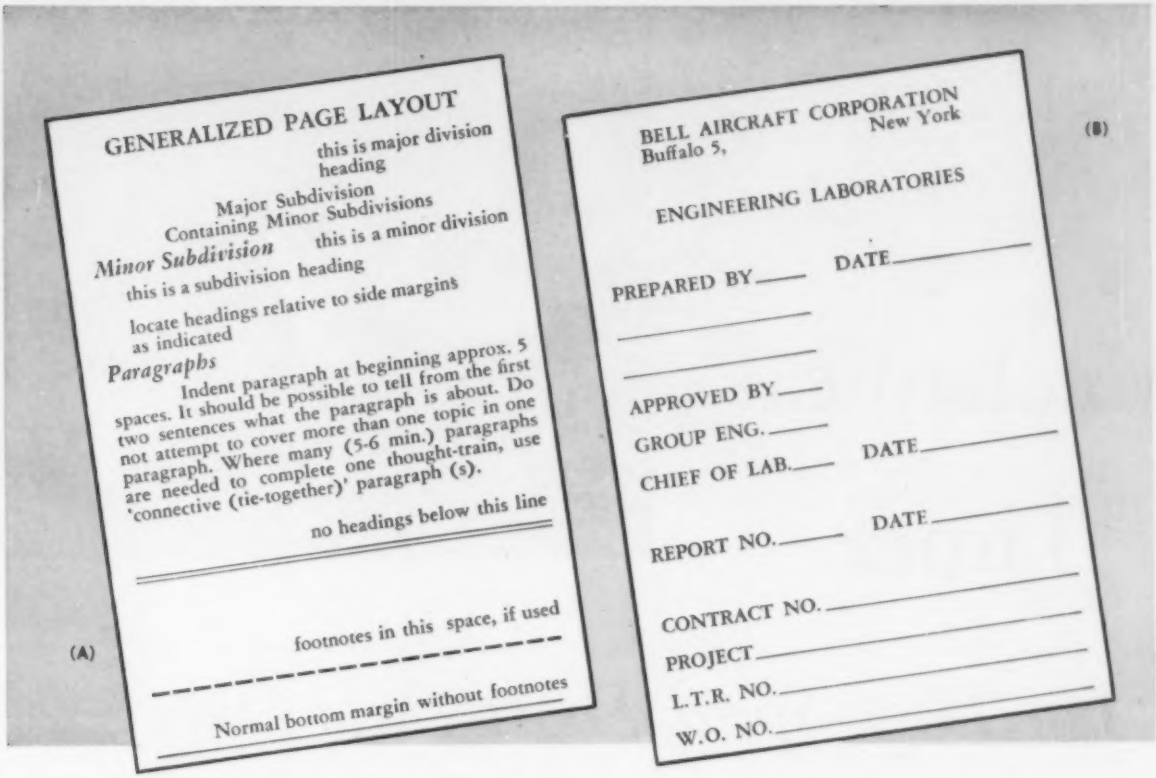
DISCUSSION OF PERFORMANCE CURVES
- Trends of Calculated Performance
- Comparison with Experimental Results

CONCLUSIONS

APPENDIX A: BLADE FRICTION LOSSES

APPENDIX B: NET DEFLECTION

REFERENCES Tables, Figures


GENERALIZED PAGE LAYOUT
this is major division heading
Major Subdivision
Containing Minor Subdivisions
Minor Subdivision
this is a minor division
this is a subdivision heading
locate headings relative to side margins as indicated
Paragraphs
Indent paragraph at beginning approx. 5 spaces. It should be possible to tell from the first two sentences what the paragraph is about. Do not attempt to cover more than one topic in one paragraph. Where many (5-6 min.) paragraphs are needed to complete one thought-train, use 'connective (tie-together)' paragraph (s).
no headings below this line
footnotes in this space, if used
Normal bottom margin without footnotes
(A)
BELL AIRCRAFT CORPORATION
Buffalo 5, New York
ENGINEERING LABORATORIES
PREPARED BY
DATE
APPROVED BY
GROUP ENG.
CHIEF OF LAB.
DATE
REPORT NO.
DATE
CONTRACT NO.
PROJECT
L.T.R. NO.
W.O. NO.
(B)

(A) is a suggested layout for the title page, a generalized page layout being shown in (B). They both represent formats that are aimed at simplifying the report preparation and standardizing the report within a company. It is only by building the technical report about a set of conditions from which a framework is derived that the report can maintain and improve its present position as an important engineering tool.

SAMPLE 4

MECHANISMS OF FAILURE OF HIGH NICKEL-ALLOY TURBO-JET COMBUSTION LINERS

John W. Weeton

NACA, TN No. 1938, October 1949
45pp, 17 figures, 3 tables, 3 references

* * *

SUMMARY

INTRODUCTION

APPARATUS AND PROCEDURE
- Liners
- Metallurgical Examination
- Production of Thermal Gradients in Type-B Liner
- Chemical Analysis
- Heat Treatments and Mechanical Finishing

RESULTS
- General Description of Macrocroaks
- Surface Examination & Chemical Analysis
- Thermal Gradients in Liners
- Metallurgical Investigation
- Trial Heat Treatments
- Heat Treatment and Mechanical Finishing

DISCUSSION OF RESULTS

SUMMARY OF RESULTS

CONCLUDING REMARKS
- The following observations may be made from this investigation: .....

REFERENCES, Tables, Figures

Aero. Sciences, AI Chem. Engrs. Inst. of Physics, Amer. Stds. Assoc. Where possibly unfamiliar terms are used, define them.

3. Employ high-quality photographic or hand-drawn illustrations and typography.

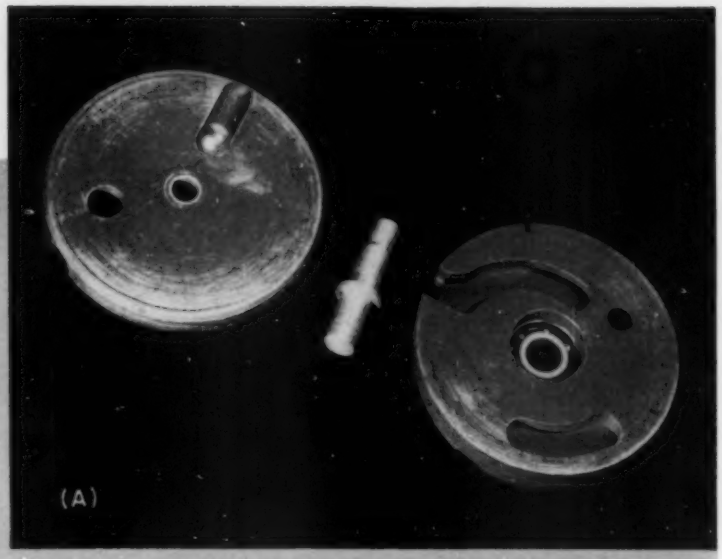
4. Include the essentials of the story in a nonrepetitious manner in the Introduction and the Results sections of the report. These will summarize the report.

5. Present and arrange all data, other tabular matter and charts to be of maximum convenience to the reader.

6. Acknowledge in the report the contributions of others who aided in the preparation and presentation.

The next step in preparing the report for writing is to move from the generalized outline, illustrated in Table I, to the specific outline covering the subject matter and circumstances of its presentation. Information contained in the explanatory pararaphs in Table I serves as a guide to the category and limitations for each division of the outline. Depending upon the subject of the report, the outline finally used may differ considerably from the over-all outline suggested as filling the maximum set of conditions. However, analysis of several different outlines covering different subjects will point up divisions that are common to each. Summary, Introduction, Discussion and Results signify approximately the same context in all reports, the widest divergence being in the Summary which depends entirely upon the problem raised. Examples of four different outlines for dissimilar subjects are shown in Table II. What has been omitted in one outline compared to another is a result of report analysis, those sections not necessary to the particular problem being omitted. Each is a word description of the specific subject-matter to be found amplified in the report proper.

Mechanical Timer



For High-Speed, Short-Cycle Duty

To introduce an accurately controlled delay of one second or less between the time that two mating members start to rotate relative to each other, a simple coupling consisting of a cam, ball and rotor can be used. Included is an analysis of the mechanisms as well as design data. Speed of operation can be as high as 100,000 rpm.

EDWIN F. SHELLEY
THEODORE K. STEELE
HAROLD G. WENIG
Bulova Research and Develop. Laboratories, Inc.

THIS MECHANISM, shown in Fig. 1(A) and (B), is a simple means of obtaining a timing cycle inversely proportional to the rotational velocity of a member. The principal advantage of this unit is that the cycle is completed with the same angular displacement of the stator housing regardless of the value of the angular velocity of the housing. Thus, such a mechanism can be used to meter the distance travelled by a rotating body. At speeds of 1,000 to 100,000 rpm, it has a practical timing range of approximately 1/1,000 to 1.0 sec.

Under the influence of the centrifugal field indicated by the spinning of the entire assembly about the axis of rotation of the rotor, the driving ball tends to move radially in the slot in the stator. Simultaneously, the ball is constrained by the spiral groove cut in the rotor, thereby exerting a driving torque on the rotor.

Taking the rotor as a free body, the forces are as represented in Fig. 2:

Since $$T = \frac{I\,d^2\theta}{dt^2}, \qquad (1)$$

$$Nr\sin\phi - fNr\cos\phi = \frac{I\,d^2\theta}{dt^2}$$

Similarly, Fig. 3 shows the system of forces taking the ball as a free body. Summing up the horizontal and vertical forces:

$$F - N(\cos\phi + f\sin\phi) - fQ = \frac{m\,d^2r}{dt^2} \qquad (2)$$

$$Q - N\sin\phi + fN\cos\phi = 0 \qquad (3)$$

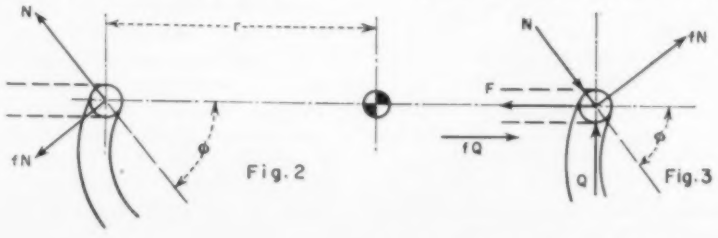


Fig. 2 Fig. 3

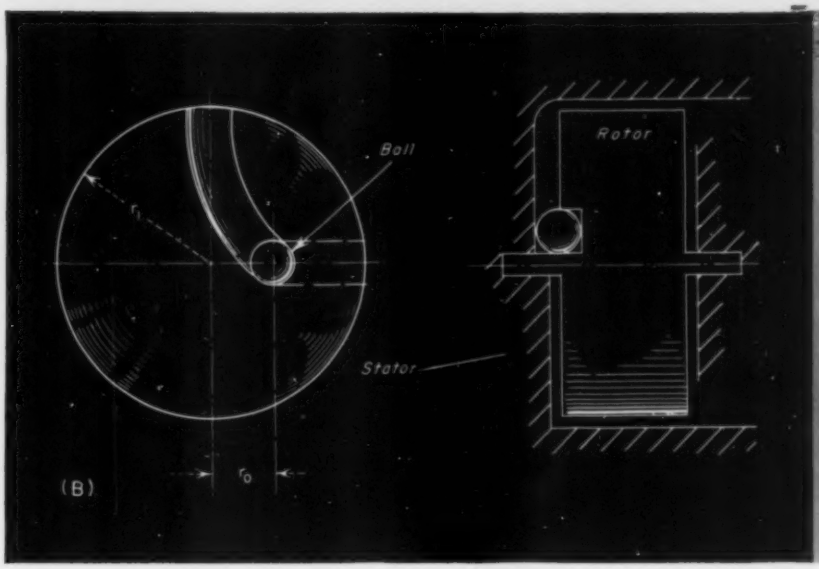


Fig. 1. Three basic components of this timing device are a stator with a radial groove, a rotor with a spiral groove, and a ball that rides in these grooves. When the mechanism rotates, the ball tends to move radially in the stator groove because of centrifugal force. As it does so, it is constrained by the spiral groove and thereby exerts a driving force on the rotor. With a constant rate spiral, curves in Fig. 5 give the time characteristics plotted against angular velocity.

Thus, Eqs (1), (2) and (3) and the geometry of the spiral groove determine the motion of the rotor. Eliminating Q from Eqs (2) and (3):

$$F - N(\cos\phi + f\sin\phi) - fN(\sin\phi - f\cos\phi) = \frac{md^2r}{dt^2} \quad (4)$$

Since $F = m\omega^2 r$, and $m\omega^2 f >> m\frac{d^2r}{dt^2}$ no appreciable error will be introduced if the right hand side of Eq (4) is set equal to zero. Therefore, Eq (4) can be written as follows for nearly all practical applications:

$$F = N(\cos\phi + 2f\sin\phi - f^2\cos\phi) \quad (4a)$$

If the second order term of the friction coefficient is neglected, the equation for normal force is:

$$N = \frac{F}{\cos\phi + 2f\sin\phi} \quad (4b)$$

Substituting this value of N into Eq (1), the motion of the rotor is expressed as follows:

$$\frac{Fr(\sin\phi - f\cos\phi)}{\cos\phi + 2f\sin\phi} = \frac{I\,d^2\theta}{dt^2} \quad (5)$$

If the groove in the rotor is chosen to be a constant rate spiral, then the geometry of the spiral can be represented as

$$r = r_0 + A\theta \quad (6)$$

Substituting $mr\omega^2$ for F, and dividing the numerator and denominator of the left hand side of Eq (5) by $\cos\theta$, the motion of the rotor becomes:

$$m\omega^2 r^2 \frac{(\tan\phi - f)}{1 + 2f\tan\phi} = \frac{I\,d^2\theta}{dt^2} \quad (7)$$

To simplify this equation, a relationship between r, θ and ϕ can be obtained from the geometry of the spiral. From Fig. 4,

$$\tan\phi = \frac{dr}{r\,d\theta} \quad (8)$$

Also, Eq (6) shows that $\frac{dr}{d\theta} = A$.

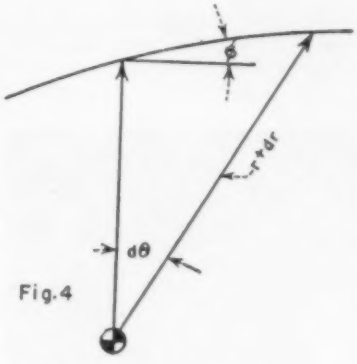


Fig. 4

Thus, Eq (8) can be written as:

$$\tan\phi = \frac{A}{r} \quad (9)$$

If this value of $\tan\phi$ is substituted into Eq (7), the result is a nonlinear differential equation. The solution of such an equation is not at all obvious so that some means of linearizing Eq (7) is desirable, if not essential.

If the spiral angle ϕ is so chosen that $\tan\theta > f$, then the expression

$$\frac{(\tan\phi - f)}{1 + 2f\tan\phi}$$

could be reduced to $C\tan\phi$ without introducing any appreciable error. The constant C could represent an average value over the range of ϕ set by the geometry of the rotor spiral.

Thus, Eq (7) is reduced to a straight-forward linear differential equation,

$$m\omega^2 r^2 C\tan\phi = \frac{I\,d^2\theta}{dt^2} \quad (10)$$

Substituting A/r for $\tan\phi$,

$$m\omega^2 CAr = \frac{I\,d^2\theta}{dt^2} \quad (10a)$$

Using the value of r from Eq (6) in Eq (10a) and transposing terms:

$$\frac{I\,d^2\theta}{dt^2} - m\omega^2 CA^2\theta = m\omega^2 CAr_0 \quad (11)$$

If the initial conditions for the mechanism are that at $t = 0$,

$$d\theta/dt = \theta = 0,$$

LIST OF SYMBOLS

- A—Spiral geometrical constant
- C—Constant
- f—Coefficient of friction for ball in rotor-stator slot
- F—Driving ball centrifugal force
- I—Moment of inertia of rotor
- m—Mass of driving ball
- N—Normal reaction of rotor on driving ball
- r—Spiral radius
- r_0—Initial spiral radius
- r_1—Final spiral radius
- t—Time
- Q—Reaction of stator on driving ball
- ϕ—Spiral angle
- θ—Rotor face angle
- ω—Angular velocity of mechanism

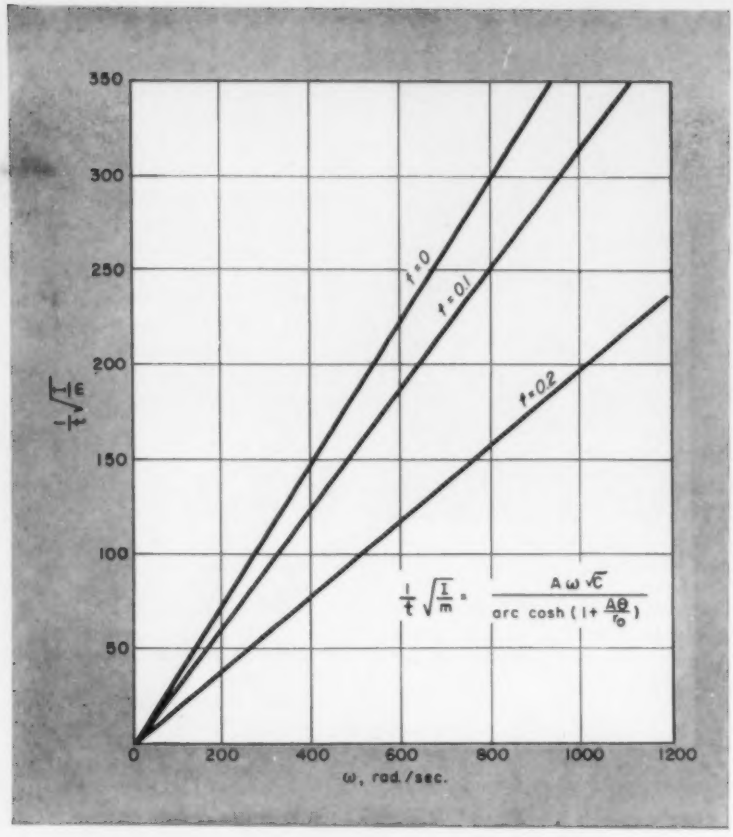


Fig. 5.—Speed-time relationship plotted for three values of the coefficient of friction. Knowing $\omega, {}^1/_t\sqrt{I}/_m$ can be read from the appropriate f curve. Then, numerical values of I and m are chosen to get the desired value of time delay.

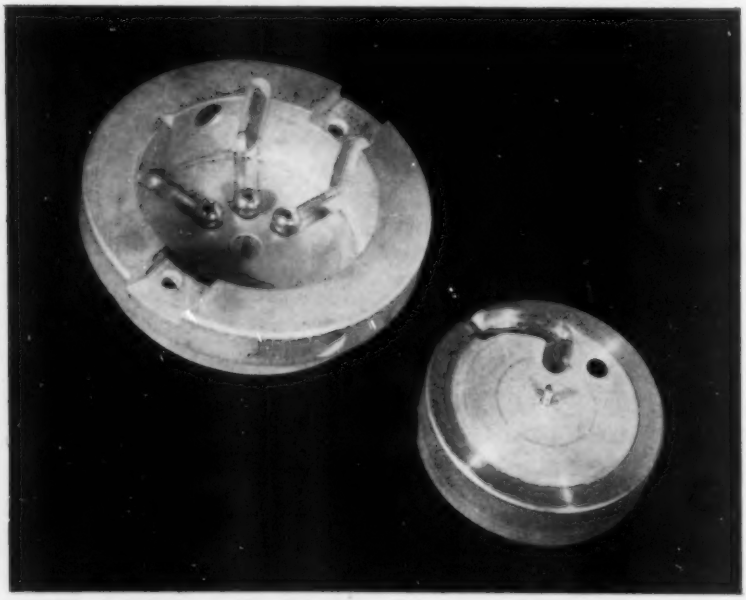


Fig. 6—Multi-stage units such as the one shown above having three balls instead of one are used to get a longer time cycle than is possible with a single stage design. This is accomplished by having each of the balls picked up in succession.

then, the solution of Eq (11) is

$$\theta = \frac{r_0}{A}\left(\cosh\frac{\sqrt{m\omega^2CA^2}}{I}\,t - 1\right) \quad (12)$$

The inverse solution of Eq (12) is

$$t = \frac{\text{arc cosh}\left(1 + A\,\frac{\theta}{r_0}\right)}{\sqrt{\frac{m\omega^2CA^2}{I}}} \quad (13)$$

For plotting purpose, Eq (13) can be re-arranged to a more desirable form:

$$\frac{1}{t}\sqrt{\frac{I}{M}} = \frac{A\omega\sqrt{C}}{\text{arc cosh}\left(1 + \frac{A\theta}{r_0}\right)} \quad (13a)$$

where by definition,

$$C = \frac{\left(1 - \frac{f}{\tan\phi}\right)}{1 + 2f\tan\phi} \quad (14)$$

Example: A unit is to be designed having an initial and final spiral radius of 0.500 in. and 1.000 in., respectively. The rotor face angle is one radian.

Thus,

$$A = \frac{r_1 - r_0}{\theta} = 0.500$$

$$\tan\phi_0 = 0.1$$
$$\tan\phi_1 = 0.5$$

If $f = 0.1$, $C_0 = 0.750$, $C_1 = 0.728$, and $C = 0.739$ from Eq. (13a)

$$\frac{1}{t}\sqrt{\frac{I}{m}} = \frac{(0.5)(\sqrt{0.739})\omega}{\text{arc cosh}\left(1\,\frac{(0.5)(1)}{(0.5)}\right)}$$

$$\frac{1}{t}\sqrt{\frac{I}{m}} = 0.326\omega$$

Fig. 5 plots Eq (13a) for three values of friction coefficient f. The use of the curves can be explained briefly. A friction factor for the driving ball in the rotor-stator slot must be assumed. From space requirements the geometry of the spiral can be ascertained. This sets the values of the term A, C, θ and r_0. For any value of angular velocity, ω, a discreet value of the term $\frac{1}{t}\sqrt{\frac{I}{m}}$ can be obtained from the proper curve. Then the values of I and m can be chosen to give the desired timing characteristic.

It should be noted that no rotor bearing friction has been considered in this analysis. If the rotor is reasonably balanced, the friction torque caused by such bearing friction is negligible except as it adds to total friction and thereby limits the maximum time cycle that can be obtained.

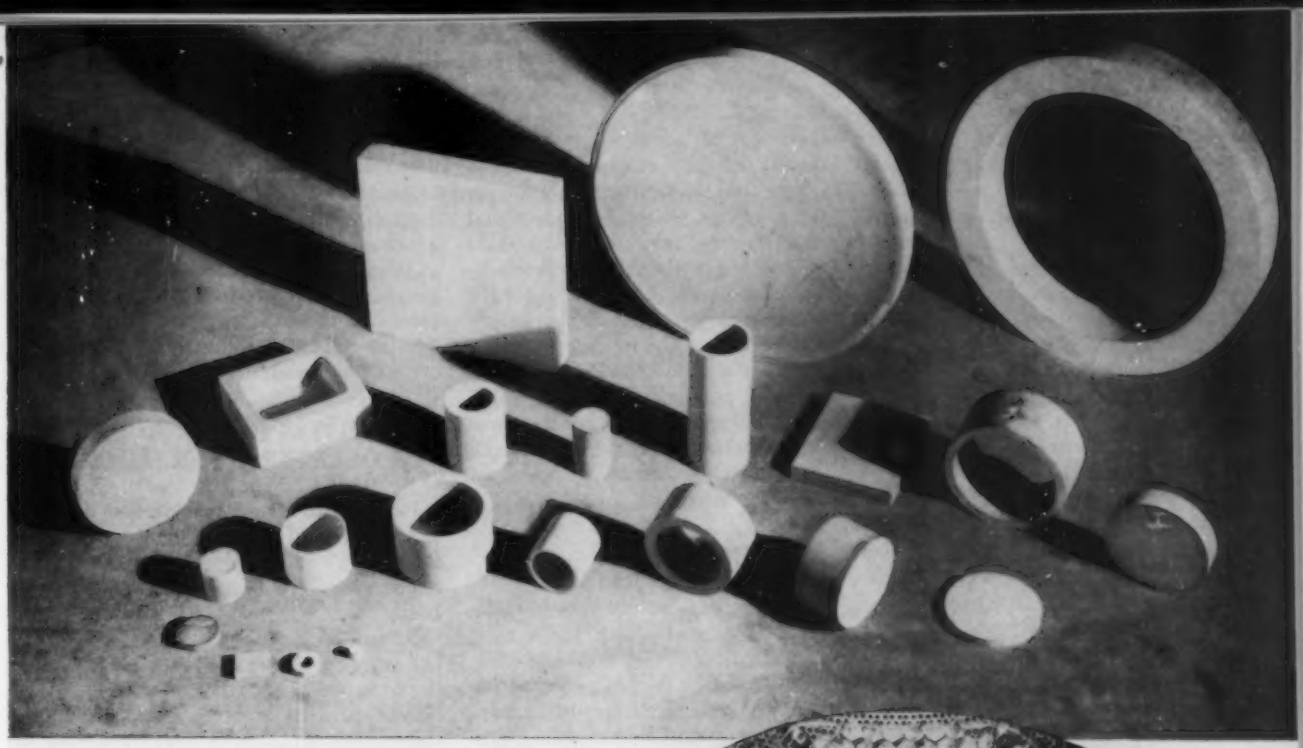


Fig. 1—Piezoelectric ceramics can be formed in various shapes and sizes not possible with other piezoelectric materials. Those shown in the illustration above are made from barium titanate.

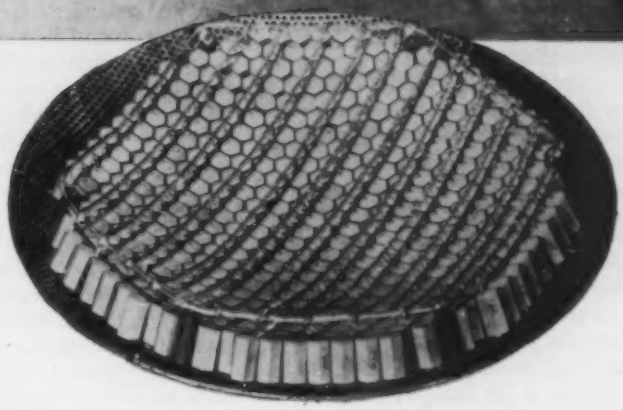


Fig. 2—A mosaic ceramic spherical focusing transducer using 440 hexagonal ceramic tiles having a resonant frequency of 100 kc, and a focal length of 12 inches. Many designs are possible.

Clevite-Brush Development Co.

Piezoelectric Ceramics

New ceramic materials for the reversible conversion of mechanical to electrical energy, are sturdier, more uniform, change less with time or temperature, and have higher conversion ratios.

PAUL L. SMITH
Crystal Branch, Naval Research Laboratory

PIEZOELECTRIC MATERIALS, Fig. 1, will convert mechanical energy to electrical energy, and vice versa, so that these materials can be used to convert a force or mechanical displacement to a voltage or electrical charge. Several applications include accelerometers, phonograph pickups, hydrophones, and ultrasonic transducers of various types.

The production of charges on the surface of a material by the application of forces is called the direct piezoelectric effect; production of a motion in the material by the application of an electric field is called the converse effect. This piezoelectric effect may be measured in several ways. For example, the material can be characterized by the amount of charge produced per unit area for a unit stress when the electroded surfaces are short circuited. This charge is measured by the charge constant d. The effect may also be defined by the voltage constant g, which

measures the amount of open-circuit voltage per unit thickness produced for a unit stress.

The electromechanical coupling coefficient k, is more generally useful than any of the fundamental constants. This coupling is the square root of the ratio of the power withdrawn from the system to the energy stored. In some applications the coupling coefficient is of direct interest, as in transducers, Fig. 2, where it indicates the usable bandwidth. Even in other applications, such as phonograph pickups where the quantity of immediate interest is the open circuit voltage, a material with a high coupling coefficient indicates better low frequency response.

Also, elastic and dielectric properties are not so easily specified as in ordinary materials. The value of Young's modulus, for instance, will depend on whether the electroded surfaces are open or short circuited; and the value of the dielectric constant will depend on whether the surfaces are clamped or free to move. For some materials, such as quartz, where the coupling is only about 10 percent, these variations in modulus and dielectric constant may usually be neglected. But for materials where the coupling ranges from 30 to 50 percent, the variations may have to be considered.

Each of the piezoelectric constants provides a measure of both the direct and the converse effect. The charge constant d, for example, measures not only the charge per unit area per unit stress, but also the strain per unit field. Thus, d will have the same numerical value whether it is given in units of Coulomb/Newton (direct effect), or in meter/volt (converse effect). Similarly, the g constant may be in volt-meter/Newton (direct effect) or in meter^2/Coulomb (converse effect). A high d constant therefore, implies not only a high charge per unit stress, but also a high strain per unit field.

In addition, it may require as many as 18 separate d or g constants to describe a material completely. That is, there may be 18 independent piezoelectric effects relating the various stress or strain components to the electric field or displacement (charge) components. For crystals in common use, however, the number is much smaller, and in the piezoelectric ceramics there are only five. In any particular application, moreover, the shape of the material is so chosen, and the conditions of operation are such that usually only one constant is needed to describe its piezoelectric behavior in the particular device. In single crystal materials, the value of this constant will depend on the value of the fundamental constants, the orientation of the specimen with respect to the crystallographic axes, and to some extent on the shape and conditions of mounting.

In the polarized ceramics there are no crystallographic axes, but the direction of polarization provides a unique axis, and all quantities are measured with reference to it.

PREPARATION

Barium titanate is the basic raw material for almost all of the current piezoelectric ceramics. Although this material may be formed by any of the standard ceramic techniques such as dry pressing, extruding or casting, production procedures are more exacting than for ordinary ceramic products. Special techniques such as centrifugal casting have been developed for certain sizes and shapes, but in general, dry pressing gives better and more reproducible results than either casting or extrusion, and should be used where the size and shape permit.

Fabrication processes vary considerably in detail. The one described here for barium titanate was developed at the Naval Research Laboratory and was found to give bodies with good properties and a high degree of reproducibility (1). The first step is the wet mixing of the barium titanate, binder, lubricant and other additives. The mixed slurry is then dried and granulated, and the parts formed by dry pressing about 10,000 psi. After forming, the piece is dried and fired for 2 hours at about 1400 C. After the piece has been fired, metal electrodes are applied by evaporating, electroplating, or firing. Usually a silver paste is painted on and fired at 600 to 700 C.

At this stage, the piece does not exhibit piezoelectric behavior until a permanent polarization is induced in the part. This is accomplished by subjecting it to a high electric field (of the order of 50 kv/in.) for about 20 to 30 min. at room temperature. Lower fields can be used if the piece is heated to about 130 C and allowed to cool while the field is applied. This so-called "hot" polarization reduces the voltage required and produces a higher coupling which is more stable with time than that produced by polarization at room temperature. This process permanently polarizes the part, making it a piezoelectric material.

The size and shape of such polarized ceramics available commercially range from thin sheets a few mils thick to large rings a half inch thick and about one foot in diameter.

PROPERTIES OF PIEZOELECTRIC CERAMICS

Piezoelectric ceramics are part of a larger group of materials known as ferroelectrics. These materials are characterized by a critical temperature, called the Curie point, at which a structure change occurs. This temperature is evidenced by a sharp peak in the dielectric constant, and the existence of dielectric hysteresis below this temperature. In the piezoelectric ceramics the permanent polarization and the piezoelectric effects disappear above the Curie point.

Of the five separate piezoelectric effects which exist in the ceramics, only three are of practical importance for acoustic applications; and of these three, two are equal, so that it is necessary to know only two piezoelectric constants to describe the material.

The first of these effects relates a field in the direction of the axis of polarization to a stress in the same direction. Since stress and field are in the same direction, it may be called the parallel effect, and quantities measuring this effect are denoted by the subscripts 33, e.g., d_{33}, g_{33} or k_{33}. The second relates a field in the direction of the polarization axis to a stress at right angles to the field, and is called a transverse or lateral effect measured by d_{31}, g_{31}, k_{31}. The subscript notation assumes that the polarized piece is referred to a system of rectangular axes x_1 x_2 x_3. The first subscript then indicates the direction of the electrical component, and the second that of the mechanical component. By convention, the direction of polarization is always taken along x_3. The subscripts thus indicate that the electrical charge or voltage is directed along this axis, while the expansion or contraction takes place along this axis and perpendicular to it, respectively.

Data are given in Table I on the essential properties of the common commercial ceramics (together with

Table I—Properties of Piezoelectric Materials

Material	Dielectric Constant	Density Kg/m³	Young's Modulus Newton/m²	Piezoelectric quantities					
				Parallel Effects			Transverse Effects		
				d Coulomb Newton	*g* Volt-meter Newton	*k*	*d* Coulomb Newton	*g* Volt-meter Newton	*k*
Barium Titanate	1800	5.7×10^3	11.0×10^{10}	190×10^{-12}	0.013	0.50	78×10^{-12}	0.005	0.22
Barium Titanate + 4% Lead Tit.	1200	5.7	11.0	150	0.013	0.40	56	0.005	0.16
Barium Titanate + 5% Calcium Tit.	1200	5.5	12.0	140	0.013	0.45	55	0.005	0.18
Quartz X-cut	4.6	2.65	7.7	2.3	0.058	0.10	2.3	0.058	0.10
Tourmaline Z-cut	7.0	3.1	16.0	1.7	0.027	0.10	....	.....	....
ADP 45° Z-cut	15.4	1.80	1.90	....	.....	....	24	0.18	0.30
$Li_2SO_4.H_2O$ Y-cut	10.3	2.06	4.6	16.0	0.175	0.36	....	.....	....
Rochelle Salt 45° X-cut	9.2	1.77	1.1	....	.....	....	28	0.28	0.30
45° X-cut (20 C)	500	1.77	1.5	....	.....	....	350	0.10	0.70
(25 C)	1400	....	0.7	....	.....	...	1160	0.096	0.85

The values given in the table are for room temperature and are in mks units. The Young's modulus is for constant field (short circuit) and the dielectric constant is measured at 1000 cycles (mechanically free). Data on the crystalline materials in this table from Mason (2) and Cady (3). Values for the ceramic materials vary depending on minor variations in composition and on fabrication. Values given here for barium titanate are typical of well fabricated material. Values for the calcium and lead additions from Berlincourt and Kulcsar (4) and Berlincourt (5). Legend: d—charge constant; g—voltage constant; k—electromechanical coupling coefficient.

values for some piezoelectric crystals. The values for the crystalline materials are not necessarily the fundamental constants, but are for bars of the particular orientation specified. The orientations chosen are those which would produce longitudinal motions rather than shear, as the piezoelectric ceramics are used principally for acoustic applications, and the comparisons with other materials are made on that basis.

It can be seen that the piezoelectric ceramics have larger values of the parallel coupling than other materials; higher charge constants and higher dielectric constants than any, except X-cut Rochelle salt in the neighborhood of its Curie temperature (25 C).

Although it is not indicated in the table, the ceramics also respond to a hydrostatic pressure. Charges appear on the faces perpendicular to the polarization axis when a piece is subjected to uniform pressure on all sides. Lithium sulfate and tourmaline are the only other materials in the table which have a similar property.

The dielectric and mechanical losses for the various materials are not listed in the table, but are important for some applications. Dielectric loss (dissipation factor) in well-fabricated barium titanate should be less than 1 percent. This is much higher than in the single crystal materials listed, with the exception of Rochelle salt near its Curie point.

Both the dielectric constant and the piezoelectric effects tend to decrease with time, representing some sort of stabilization process going on within the material. These changes are exponential, and after an initial aging period of a week or two, amount to about 10 percent in the year following.

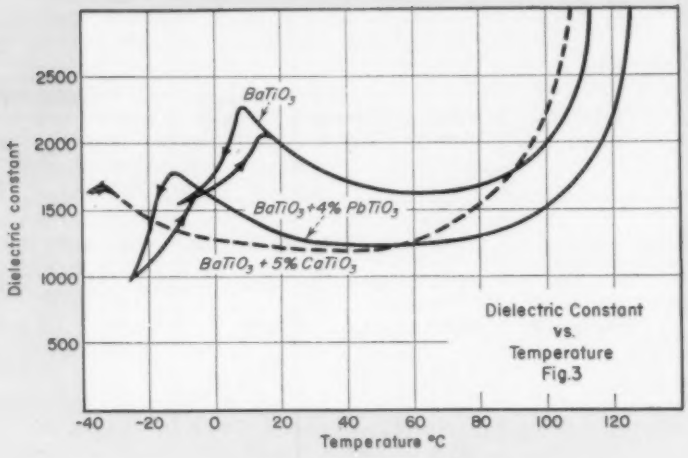
TEMPERATURE COEFFICIENTS

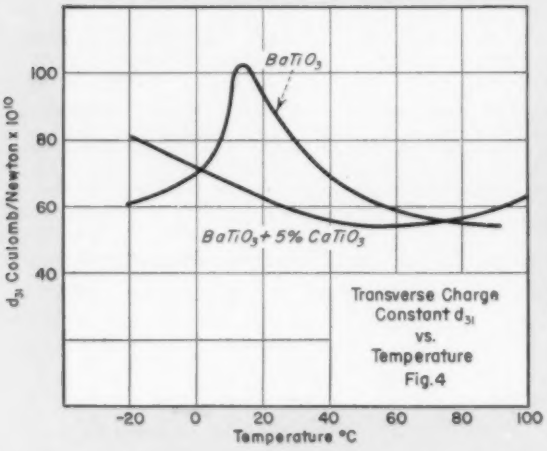
In addition to the transition at the Curie temperature of about 120 C, barium titanate undergoes a second transition point slightly below room temperature. For pure barium titanate, this occurs at about 10 C, and is shown by peaks in the dielectric constant, piezoelectric charge constant, and the dielectric loss. The elastic properties are also seriously affected, since these peaks so close to room temperature result in large temperature coefficients in the room temperature range. Certain additions will shift the second transition temperature to lower temperatures, and thus provide materials with much lower temperature coefficients in the room temperature range.

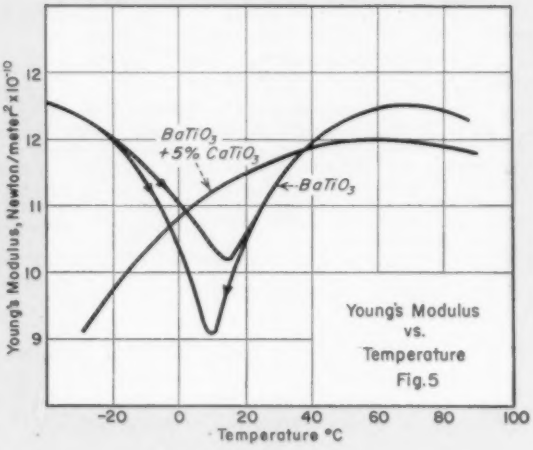
Curves for the dielectric constant, transverse charge constant, and Young's modulus for temperatures from 40 to 140 C are shown in Figs. 3, 4, and 5 for both barium titanate without additions, and with additions of calcium titanate. The shift in the peak values of the properties and the improvement of behavior in the room temperature range is clearly shown.

The curves also show that for both the dielectric constant and the Young's modulus there is a temperature hysteresis; so that values of the quantities depend not only on the temperature, but on whether this temperature was reached from above or below. The

Figs. 3, 4, 5—Curves for the dielectric constant, transverse charge constant, and Young's modulus versus temperature, respectively, for both barium titanate without additions, and with additions of calcium titanate in the amounts ordinarily used in commercial bodies. By even larger additions of calcium titanate, or by additions of calcium and lead titanate together, the variations of Young's modulus with temperature can be made small over a wide temperature range.







additions are found to reduce the amount of this hysteresis.

The dielectric loss also shows peaks which are shifted by the additions. Calcium titanate not only shifts the loss peak to a lower temperature, but reduces it considerably.

APPLICATIONS

The high coupling and the high dielectric constant make the ceramic superior to other materials for some applications, particularly where use can be made of the parallel effect. Typical devices using piezoelectric ceramics are given in references 7 to 14.

For phonograph pickups, microphones, and similar devices, material is used in the form of thin sheets made into composite strips, which when bent, develop a charge through the transverse effect. Principal advantages of the ceramic for these uses are high dielectric constant, which gives a relatively low impedance, resistance to moisture, and the ability to operate as high as 90 C without damage.

Both transverse and parallel effects are used in various forms of hydrophones which frequently make use of cylindrical shapes. The hydrostatic response also permits the use of ceramics in small probe hydrophones. As with microphones and pickups, the high dielectric constant is of value in reducing the effect of losses in connecting cables. The same properties, together with sturdiness, have also been responsible for wide use of ceramics in accelerometers. (Ref. 9 & 10).

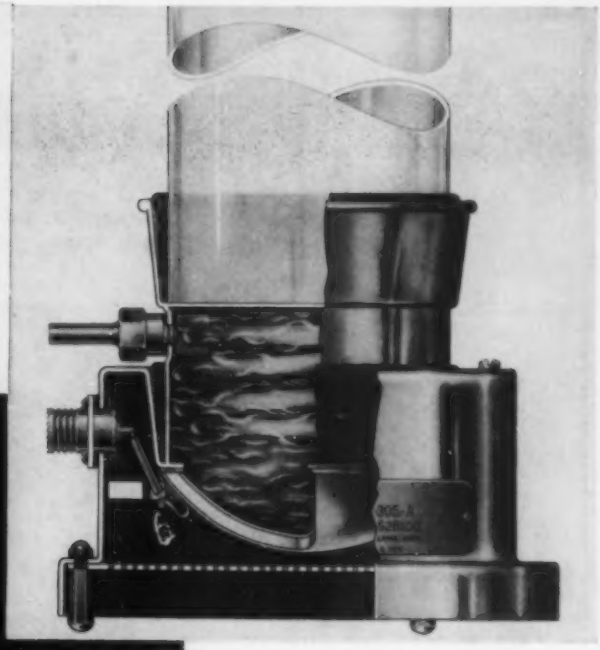
A high charge constant implies a large motion for a given applied field. This property of the ceramics has been exploited in special ultrasonic devices for testing wear resistance and for cutting various materials. (Ref. 11 & 12).

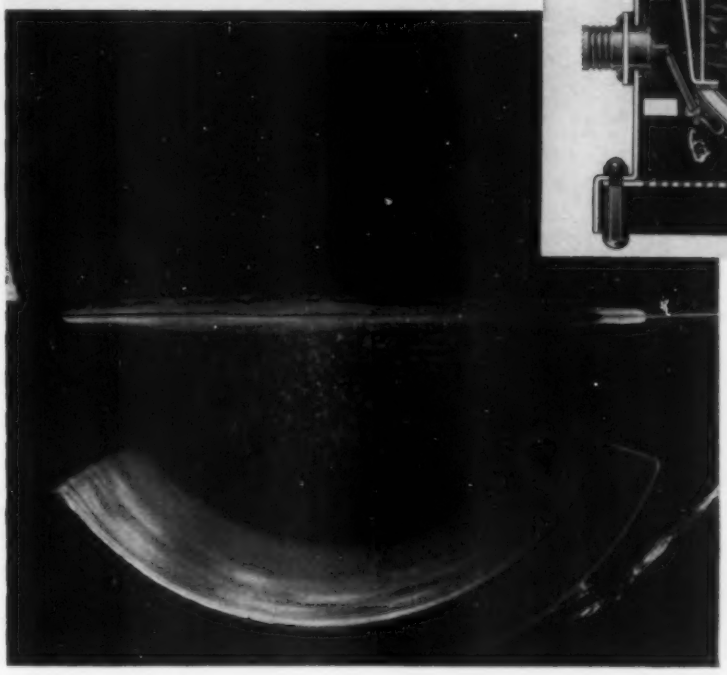
The properties of the ceramic materials appear to best advantage in ultrasonic transducers for converting large amounts of power, particularly when it is desirable to operate over a relatively wide band of frequencies, for which a high coupling is essential. (Ref. 13 & 14). For this use, the high coupling, low impedance, and ease of forming curved shapes provide the designer with many new possibilities. Ultrasonic energy has been used to: emulsify liquids, clean small parts, ac-

Fig. 6—(Right) Cutaway view of an ultrasonic generator showing a ceramic focusing transducer for 600, 800, or 1000 kc having a sherical shape with a diameter of 4 in. and a focal length of 2½ inches.

Fig. 7—(Below) The converging sound waves in a cleaning fluid showing the focusing action of a trough transducer.

Clevite-Brush Development Co.





celerate aging of alcoholic spirits, stimulate or destroy bacteria, mix paint, transform chemical compounds, and others. The limiting factor in the present materials is the heat from the mechanical and electrical losses during operation. This heating may be severe enough to raise the temperature of the ceramic during operation close to its Curie point with resultant loss of polarization. Progress toward overcoming this difficulty is being made through studies of the behavior of the material under bias (15).

For applications such as high frequency oscillator control or crystal filters where the requirements are low loss, uniformity and high stability with time and temperature, current ceramics are not so suitable as other materials.

RECENT WORK

Other compositions and other materials besides those listed in Table I are being explored. Zirconates, niobates, larger additions of calcium and lead, and major additions of more than one component have provided materials useful for special purposes. Usually it is necessary to sacrifice some of the properties, such as dielectric constant or coupling coefficient, to obtain a special property such as low temperature coefficient, improved open-circuit voltage, or higher Curie points.

These newer compositions together with improved fabrication techniques and closer control of the basic raw materials should extend the usefulness of piezoelectric ceramics.

REFERENCES

1. R. M. Callahan and J. F. Murray, Bulletin of the American Ceramic Society, 33, 131, (1954).

2. W. P. Mason, Piezoelectric Crystals and Their Ultrasonic Applications, Van Nostrand, 1950.

3. W. G. Cady, Piezoelectricity, McGraw-Hill, 1946.

4. D. A. Berlincourt and F. Kulcsar, J. Acoustical Soc. America *24*, 709 (1952).

5. D. A. Berlincourt, personal communication.

6. W. P. Mason, Bell Laboratories Record *27*, 285 (1949).

7. L. G. Hector and H. W. Koren, Electronics *21*, 94 (1948).

8. H. W. Koren, J. Acoustical Soc. America *21*, 198 (1949).

9. Electronics *24*, 274 (1951).

10. G. K. Guttwein and A. I. Dranetz, Electronics *24*, 120 (1951).

11. W. P. Mason and R. F. Wick, J. Acoustical Soc. America *23*, 209 (1951).

12. W. P. Mason and S. D. White, Bell System Technical Journal *31*, 469 (1952).

13. O. Mattiat, J. Acoustical Soc. America *25*, 291 (1953).

14. L. Camp, J. Acoustical Soc. America *25*, 297 (1953).

15. H. G. Baerwald and D. A. Berlincourt, J. Acoustical Soc. America *25*, 703 (1953).

PART I

Designing for Production

Efficient, simple and economical production calls for the most advantageous use of labor, machines and methods. Often a simple design change will increase machine

FIG. 1—Casting or forging with a large tapered hole. If the conical section is to be held to close tolerances and is not a standard taper for which a plug gage is available, the size will be difficult to check during machining and inspection. Repeated caliper checks would have to be made during the boring operation, (A). An accurate measurement would be difficult to obtain, because the depth at which the diameter is measured is hard to define. (B) shows a simple change that eliminates these problems. The counterbore or recess need only be about $\frac{1}{8}$ in. deep, but should be approximately 0.004 in. less than the critical maximum diameter of the finished hole.

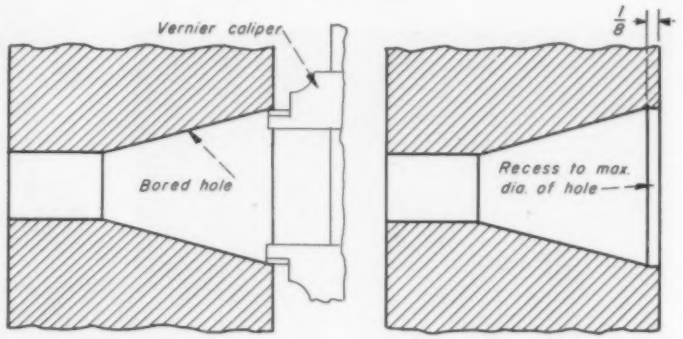


Fig. 1

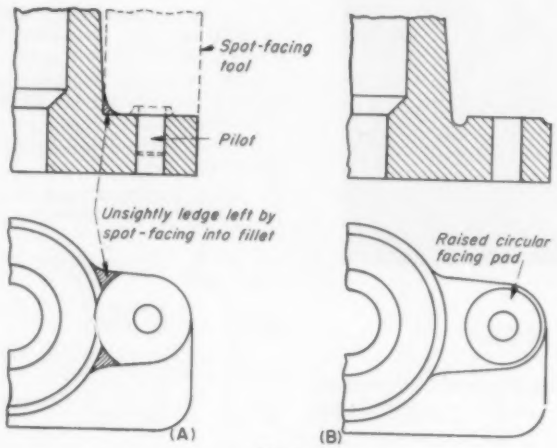


Fig. 2

FIG. 2—Lug formed on the external wall of an iron, brass or light-metal casting. To form a flat, clean seat for the bolt head, these lugs are cleaned with a pilot-type spotfacing tool, (A). If a large radius strengthening fillet adjoins the lug, an unsatisfactory finish can result. The spot-facing tool will cut partially into the fillet and leave triangular raised ledges. Moreover, an unequalized pressure—caused by cutting into the fillet—is imposed upon the tool. This can cause the pilot to be broken or bent, or else the teeth of the tool can be damaged. Cost is thus increased and production reduced. If a raised circular pad is cast, (B), there is no danger of tool catching or fillet damage. A clean, smooth surface is assured.

FIG. 3—A slotted shackle milled from mild steel stock. (*A*) shows the part with the central parallel slot milled with a perfectly flat base. This requires the table carrying the part to travel a considerable distance to allow for tool curvature. By allowing the base of the central slot to be curved, (*B*) to the radius of the milling ing cutter, it is possible that only a vertical feed, to the necessary depth, will be required.

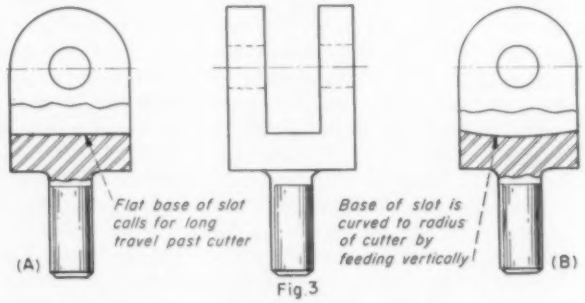


Fig. 3

....Machining

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production and reduce labor cost. This, the first of a series, shows various design modifications that can be used to simplify machining operations to improve production.

FIG. 4—Drilling a casting where hidden hole exists. To drill and tap the hole, (*A*), a long extension drill would be needed to clear the long side wall. Frequent drill and tap breakage should be expected, as well as design difficulties in providing a jig or fixture to guide the tools. If a large diameter hole can be cored through the back wall, (*B*) a standard drill and tap can be used. A simple fixture can be used to mount the part.

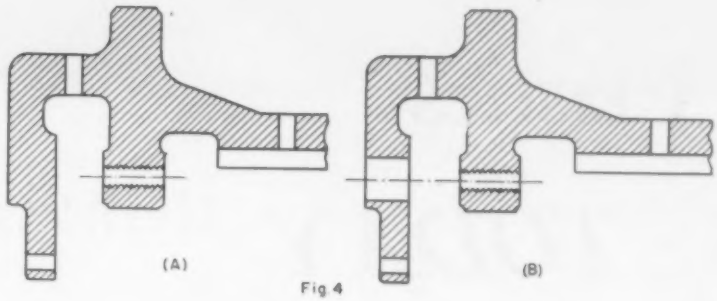


Fig 4

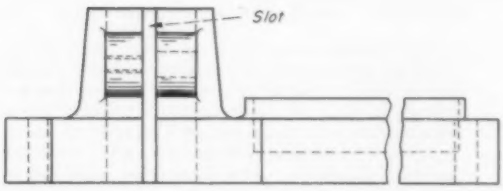


Fig. 5

FIG. 5—Drilling and tapping a slotted lug on a bored cast boss. The left wall of the lug is tapped and the right wall clearance drilled. Drilling will be difficult both in setting the part and tooling, because of the closeness of the rectangular flat base of the casting. If the holes are transposed, drilling is simplified, and the drilled hole can be used as a guide to tap the core-drill diameter.

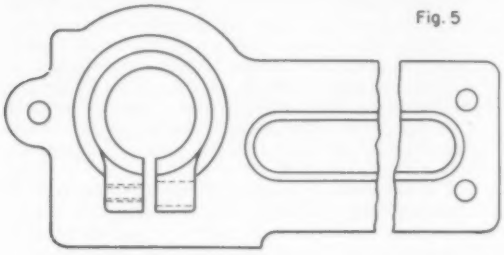


FIG. 6—Drilling holes in flanges for the fixing of a cover. A step-up or step-down design. (*A*) and (*B*) will require a new setting or a readjustment of the milling machine. Also, in (*A*) the underside of the flange is inclined, which can cause trouble when the drill breaks through. In (*B*) the drill breaks through partially into the side wall. (*C*) provides for a single milling operation, and the parallel underside assures that the drill breaks through cleanly.

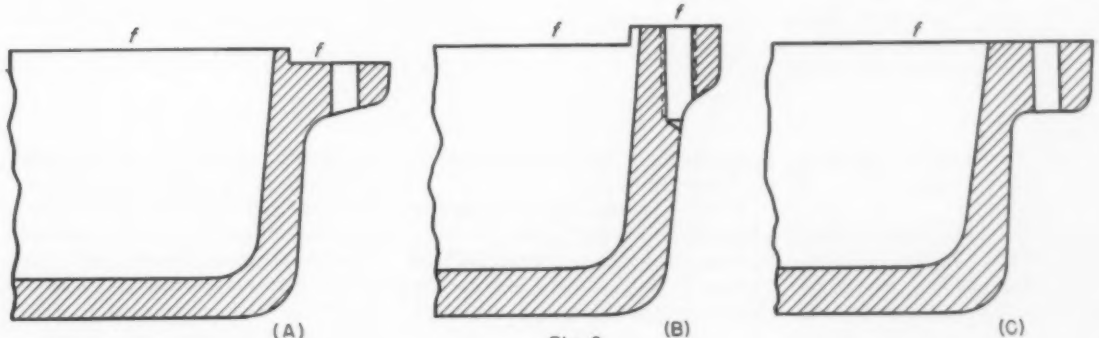
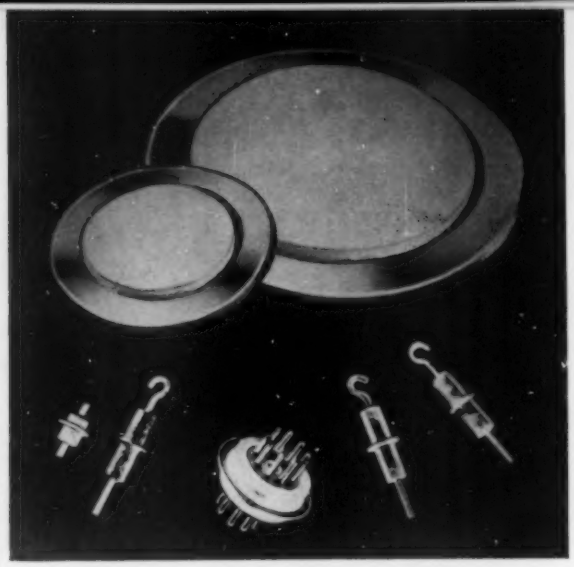


Fig 6



Fluorocarbon Plastics TODAY

Distinguished from other plastics by their greater resistance to chemicals and temperature, the fluorocarbons are of two basic types, thermoplastic rigid and non-rigid. This article stresses their significant differences to aid in selection, and reviews in detail the thermoplastic rigid type, trifluorochloroethylene, in terms of new service property information and the more promising potential commercial applications.

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UNTIL THE DEVELOPMENT of fluorocarbon plastics, no one group of existing materials could

- maintain high insulation resistance of 10,000-30,000 megohms under severe heat cycling and high humidity;
- withstand high temperature-corrosive conditions such as those imposed by boiling nitric acid;
- retain an appropriate degree of flexibility at —320 F; and
- be produced in molded and extruded forms, laminated to other materials, or applied to wire insulation.

Since fluorocarbons are so adaptable, their use has expanded constantly despite relatively high material cost. Today, the two basic types of fluorocarbon plastics are represented by three materials: *non-rigid,* polytetrafluoroethylene,** or Teflon, produced by E. I. du Pont de Nemours and Co.; and *thermoplastic rigid,* trifluorochloroethylene, identified as Kel-F, first pro-

* *Opinions expressed are those of the author and not necessarily those of North American Aviation, Inc.*
** *Note the addition of "poly" to this term indicating that it is the polymer form. The prefix is omitted hereafter but the polymer form is implied.*

Fluorocarbon

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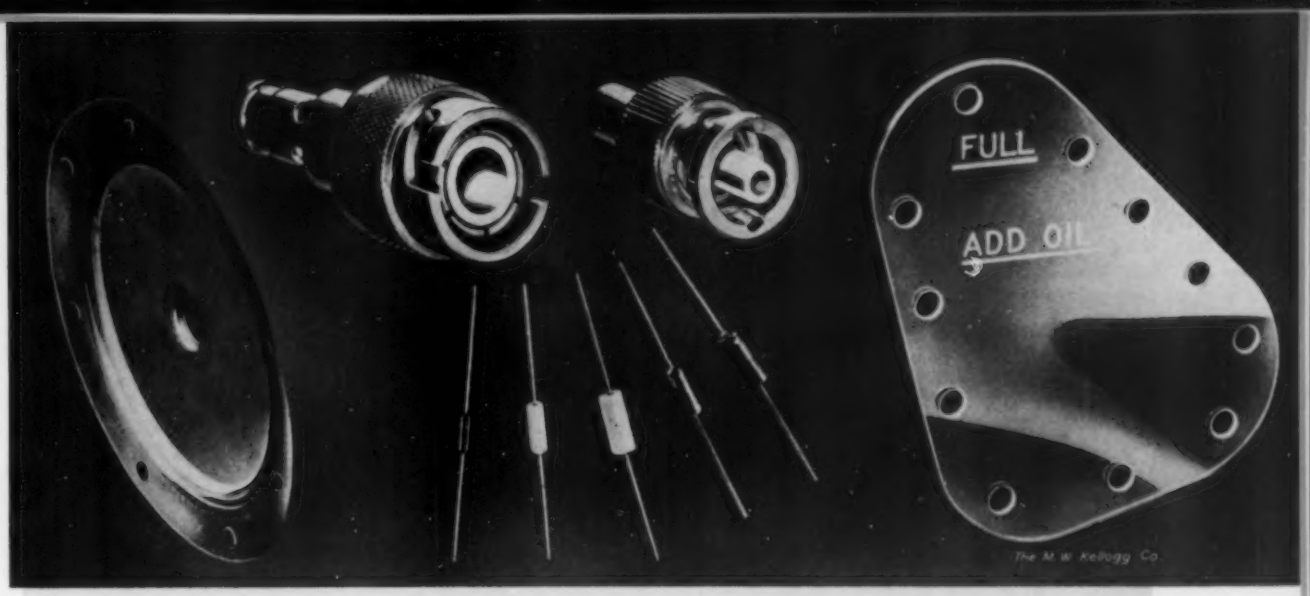
The M. W. Kellogg Company

New developments in fluorocarbon formulation, quality control, molding technique, and testing forecast a field of use far beyond that of molding and extrusion. Future application will be in lined valves, pipe, coated wire for power and control systems of complex construction, laminates of glass, metal and textiles, thicker extruded sheets, and sterilization-resistant packaging materials.

Formulation . . . most recent development is that of a high-temperature Kel-F elastomer, a fluorocarbon rubber. This material has excellent chemical resistance, heat stability to 400 F, extreme resistance to ozone, oxygen, weathering, low moisture absorption, good electrical properties, wide compatibility with other rubbers, and unlimited color possibilities. These elastomers will be available in pilot plant quantities in the spring of 1955.

In dispersion form, Kel-F is a convenient means of coating large areas of metal and ceramics. Present development is focused towards improved adhesion and one-coat applications of 3-6 mil films.

Expanding production facilities will make large quantities of fluorocarbon oils, greases, and waxes more readily available—with higher standards of



Plastics *TOMORROW*

uniformity, chemical stability, and lubricity. In addition to their use as plasticizers, impregnants and lubricants, these oils will serve as raw materials for other fluorocarbon products.

Highly specialized compounding is introducing conductive and resistor fluorocarbon inks for high temperature printed circuit applications. Within the past few months, printing and wire striping inks were introduced for Kel-F, since its chemical inertness makes special ink necessary for best adhesion.

In molding materials, the use of fillers will not only assist in reducing material costs, but also introduce compounds for special application such as bearings, packing, and valve seats.

Molding techniques . . . new materials often require new and modified molding techniques. Recently introduced by the M. W. Kellogg Company for trifluorochloroethylene molding was the hot runned molding technique, in which scrap will be reduced to a minimum, as opposed to that obtained with the cold runner method. All parts can be molded with virgin powder. In addition, this process will result in improved degrees of orientation, lamination and general toughness.

Application . . . valves can be dispersion coated or coated with a heavier section of fluorocarbon, from ☆ to ¼ in. thick, by transfer or injection molding methods. Thus, it is possible to line relatively cheap castings with a substantial coating of fluorocarbon to give them complete chemical resistance.

Directly connected to the valve applications are conduits and pipes which require the same degree of chemical resistance. Low priced carbon steel pipe will be lined with heavy sections of fluorocarbon in various ways. Heavy gage pipe will also be required for certain applications, particularly, the food, chemical and pharmaceutical fields. Pipe construction, using fluorocarbon laminate and glass fiber as liner material can also be expected.

Increased interest in the use of Kel-F laminates made of glass cloth and the newer synthetic materials indicates new fields of application. Techniques for sealing joints have been developed, thus fostering application of the laminates to surfaces of unlimited size. Furthermore, by combining a heavy gage Kel-F barrier with a common bonding material, it will be possible to realize excellent adhesion to a great variety of surfaces. This adhesion can be obtained at room or slightly elevated temperatures.

Kel-F coated wire has proven useful where high temperatures, corrosive fumes, high humidity and excellent electrical properties are desired. Improvements in the basic material characteristics, such as flow, will also be manifested in the higher production rates. Studies under way indicate that the use of silver plated wire may not always be required.

duced by the M. W. Kellogg Co.; and Bakelite Fluorothene, produced by Union Carbide and Carbon Corp.

There are applications where nonrigid tetrafluoroethylene will serve satisfactorily and others where only rigid trifluorochloroethylene will serve best. In other instances, any combination of the two materials can be used to best advantage.

DIFFERENCES BETWEEN BASIC TYPES

The difference between the nonrigid and rigid type—in fabrication methods, physical characteristics, and properties—can be attributed to a basic structural difference. In both types, fluorine is responsible for chemical inertness and zero moisture absorption. But in the rigid type, chlorine in the fluorocarbon molecule contributes to exceptional flow, transparency and rigidity characteristics.

Fabrication. Rigid Kel-F can be injection molded around inserts to fairly accurate dimensions. Non-rigid, Teflon, however, cannot be molded into complex shapes because of its inher-

ently poor flow characteristics. In addition, a molded non-rigid product might vary primarily in density from part to part, depending upon the nature of the basic powder and the molding techniques. But, since the rigid type is homogeneous during hot injection into a cavity, the molded part has essentially the same finished density. To check complete homogeneity of non-rigid material, dyes must be used to measure porosity in the castings, as there might be a variation in density within the casting itself. In general, the non-rigid type can be handled readily on slightly modified conventional compression, injection, extrusion and transfer molding equipment while the rigid type cannot.

Physical Characteristics. Rigid Kel-F can be clear and transparent; non-rigid Teflon is essentially opaque. Since Kel-F has a clear, transparent base, colors can be added to produce vivid differences in shades. The rigid type Kel-F can also be made opaque, transparent or translucent by the addition of pigments and dyes. The optical clarity of this type is such that it can be used for sight glasses, or infrared windows of different types.

Mechanical Properties. The electrical and mechanical properties of rigid Kel-F and non-rigid Teflon differ quite markedly. As shown in Table I, the tensile strength, compressive strength, flexural strength and Shore hardness of the rigid fluorocarbons are greater than those of the non-rigid.

Rigid fluorocarbon is a poorer conductor of heat than the non-rigid type and is lower in thermal expansion and resistance to heat. Both, however, can be used effectively at very low temperatures. Kel-F has been used at —330 F and can be flexed through 180 deg without ill effect. To a great extent, cross-sectional thickness is a significant factor, since high fiber stresses can be expected on the surface of heavier sections, particularly when subjected to a 180-deg bend.

Volume resistivity and dielectric strength of the rigid material are greater than that of non-rigid. Dielectric strength of the rigid by the step-by-step method is slightly less than that of the non-rigid. However, the dielectric constant and dissipation factor of the rigid are less.

It is important, of course, that the molded article maintain the property values obtained on test specimens under ideal conditions. Thin films and coated wire, for example, may be porous due to the sintering technique used when coated with Teflon, whereas Kel-F in a film or solid form, is homogeneous and non-porous. Kel-F films, three mils and thicker, halt moisture vapor transmission completely. The chemical resistance and anti-stick properties of both materials are essentially similar.

Cost Comparisons. In many cases, it is not the initial material cost that must be considered as the sole basis for selecting the proper material for the application. Since rigid trifluorochloroethylene can be injection molded and readily extruded, it can be produced at a lower cost than a comparable part of non-rigid tetrafluoroethylene, which may have to be molded by a slower method and subsequently machined. On a poundage basis alone, the non-rigid material costs approximately half that of the rigid. Cost, however, will obviously decrease as increased production facilities become available. Having recently completed a new plant for the production of trifluorochloroethylene, the M. W. Kellogg Company has announced price reductions of 25-45 per cent. Bakelite has also expanded its production facilities for this material.

Table I—Physical Properties of Fluorocarbon Plastics

Property	Non-Rigid* (Tetrafluoroethylene)	Rigid** (Trifluorochloroethylene)
Specific gravity	2.1–2.3	2.1
Refractive index, n_ρ	1.35	1.43
Tensile strength, psi	1,800	4,600–5,700
Elongation, per cent	110	28–36
Modulus of elasticity in tension, 10^5, psi	0.58	1.9
Compressive strength, psi	1,700	32,000–80,000
Flexural strength, psi	1,600	8,200
Impact strength, Izod, ft-lb/in. of notch	2.5–4.5	3.0–4.0
Hardness, Shore	D55	D80
Thermal Conductivity, Btu/sq ft/hr/F/in.	1.7	0.418
Specific heat, cal/C/gm	0.25	0.22
Heat distortion temp, F(66 psi)	270	.....
Volume resistivity, ohm-cm, 50 per cent R.H. at 23 C	10^{15}	1.2×10^{18}
Dielectric strength, v/mil: (1/8 in. thickness)		
Short time	480	530
Step by step	430	390
Dielectric constant:		
60 cycles	2.0	2.8
10^3 cycles	2.0	2.5
10^6 cycles	2.0	2.5
Dissipation factor:		
60 cycles	0.0002	0.015
10^3 cycles	0.0002	0.024
10^6 cycles	0.0002	0.010
Arc resistance, sec	>200	>360
Water absorption, per cent, (24 hr, 1/8 in. thickness)	0.00	0.00
Flammability	nil	nil

Data courtesy of:
* E. I. du Pont de Nemours & Co. ** The M. W. Kellogg Company

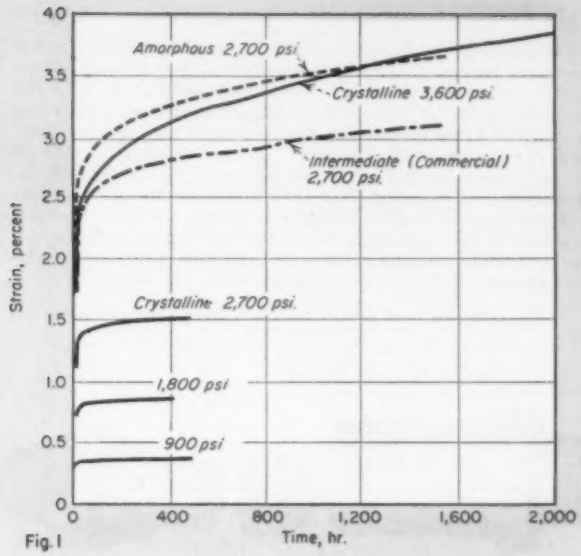
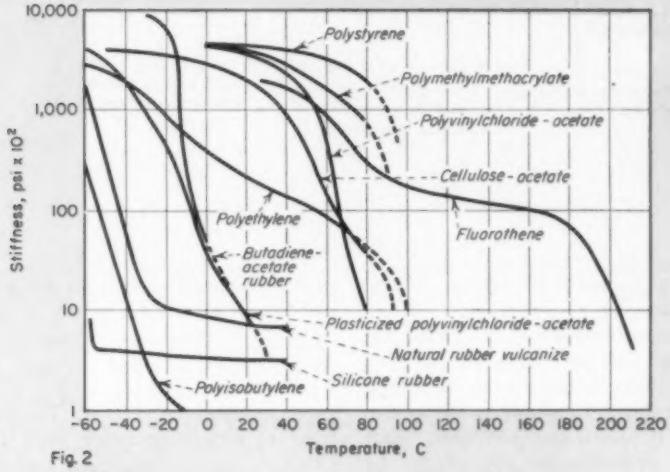
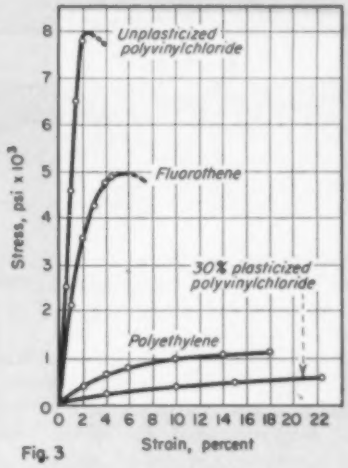


Fig. 1—Creep curves for Kel-F at different stresses and three different degrees of crystallization. Tests were conducted at room temperature; 50 per cent relative humidity.

Fig. 2—Stiffness vs temperature curves for Bakelite fluorothene, polyethylene and other prominent plastics and rubbers. Fluorothene exhibits less change in stiffness over a wide temperature range than any other plastic.

Fig. 3—Fluorothene has a tensile strength of 4,000-5,000 psi, midway between that of the rigid plastics and the softer elastomers.





RIGID TRIFLUOROCHLOROETHYLENE

Mechanical Properties. This material is a visco-elastic plastic; strain is proportional to stress as well as to the length of time stress is applied. Trifluorochloroethylene is rated as a low creep material compared to elastomers, but does exhibit more creep than the rigid plastics, such as styrene and methacrylate. Creep data for Kel-F are shown in Fig. 1. Similarly, the material is stiffer than elastomers but slightly more flexible than the rigid plastics. Fig. 2 portrays this relationship and also reveals that the material changes less in stiffness over a very wide range of temperatures than any of the other plastics.

The unplasticized material has a compression molded tensile strength of 4,000-5,000 psi. As shown in Fig. 3, this range lies between that of the rigid plastics and the softer elastomers. Plasticized trifluorochloroethylene has a tensile rating in the same range as the elastomers, as also shown in Fig. 3. In addition, the unplasticized material has the highest compression strength of any thermoplastic—ranging from 32,000 to 80,000 psi, depending on crystallinity. Because the trifluorochloroethylene molecule is a long, chain-like one with a regular repeating link, parallel chains tend to orient with each other and produce a certain degree of crystallinity. These crystals can build into groups or nodes called spherulites. The presence of large spherulites results in an increase in the tensile strength with a corresponding increase in brittleness.

Strength as well as stiffness is a function of the crystallinity of the polymer. The rate of crystallization increases with decreasing molecular weight. As crystallinity increases, strength and stiffness increase, yielding a stronger but more brittle product.

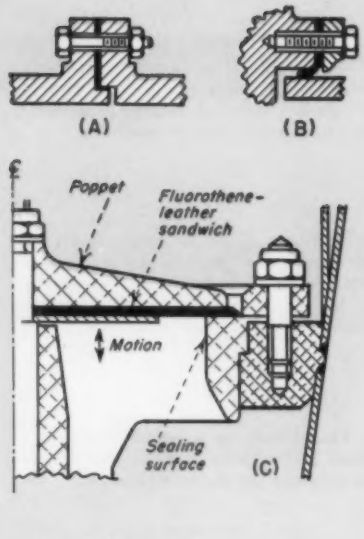
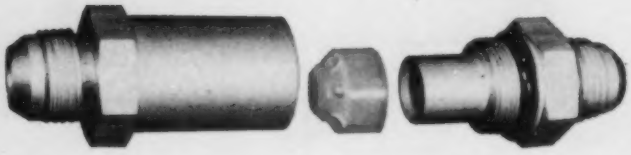


Fig. 4—Radial seals of fluorocarbon plastic are not satisfactory at low temperatures because of the high contraction rate of the seal. Three successful types of seals using fluorocarbon plastic are (A) flat gasket, (B) lip and (C) vent valve. Gaskets have proved successful since contraction rate of material has little effect on loosening joint. Flanges must be reasonably rigid and bolt spacing relatively close to insure uniform gasket loading. In the preformed lip seal of 0.005 in. thick fluorocarbon, contraction of lip improves sealing ability. This type of seal has been used for pressures as high as 1,000 psi. The vent seal utilizes a sandwich made of leather heat sealed between two sheets of fluorocarbon plastic. Land on outside of sharp sealing edge limits unit loading of seal after seal has seated on sharp ridge.

North American Aviation, Inc.



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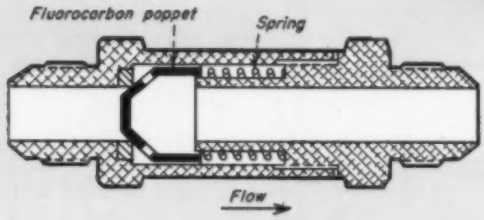

Fig. 5—Liquid oxygen check valve with fluorocarbon poppet. Non-sticking and impact properties of fluorocarbons at low temperatures are of value in this service.

The rate of cooling of the fabricated product from the molding point to below 300 F strongly influences both strength and stiffness. Rapid cooling produces greater flexibility by reducing crystallinity. Thus, variations in the physical properties exist due to the thermal history of a specimen; quick cooling prevents the growth of spherulites and slow cooling or annealing favors it.

The high temperature properties of trifluorochloroethylene have not proved as good as first hoped. However, the serviceability of the material at elevated temperatures is highly dependent on the application involved. It is true that where flexibility is required, it cannot be used to the fullest extent of its possibilities at elevated temperatures for an extended period of time, but heat-induced crystallization raises strength.

Aging of the material at temperatures up to 210 C (410 F) promotes spherulite growth with resultant decrease in brittleness strength. Just above this temperature, the material softens markedly, permitting molding and extrusion.

Molecular weight of the resin governs the melt viscosity of the hot plastic and thus determines the fabricating pressures and temperatures for specific mold or die shapes and sizes. Heat aging properties are also affected by molecular weight. A low molecular weight material such as Kel-F, grade 240 or less, will have a tendency to become more brittle on heat aging; a high molecular weight material such as Kel-F, grade 300, can withstand heat aging and subsequent flexing without embrittlement.

In addition to being a high temperature plastic for a thermoplastic material, trifluorochloroethylene has also demonstrated unusual low temperature toughness. Although its elongation falls off with a lowering of temperatures, and, despite a mediocre rating under the ASTM brittleness test for elastomers (which is not always applicable to a semi-rigid plastic), trifluorochloroethylene has proved to be one of the few plastics which retains a portion of its impact strength and general toughness at temperatures as low as —320 F, which are encountered in equipment using liquid nitrogen or liquid oxygen. It thus serves as a good seal material, Fig. 4. The two types of low temperature seals for which this material has been used are the flat gasket and the lip seal. It has also been applied as a check valve, Fig. 5, where its non-sticking and impact properties have made it useful.

Trifluorochloroethylene has a Shore hardness of 75-80, which is midway between that of elastomers and rigid plastics. Its volume expansion is less than that of polyethylene but greater than that of the rigid plastics. Its linear coefficient of expansion is 4.5 x 10^{-5} in./in./C in the range from —80 to 20 C, and 7.0 x 10^{-5} in./in./C from 20 to 150 C.

Electrical Properties. High insulation resistance over extended periods of severe thermocycling and high humidity has qualified trifluorochloroethylene for terminals, hook-up wire, sockets and related applications. Tests

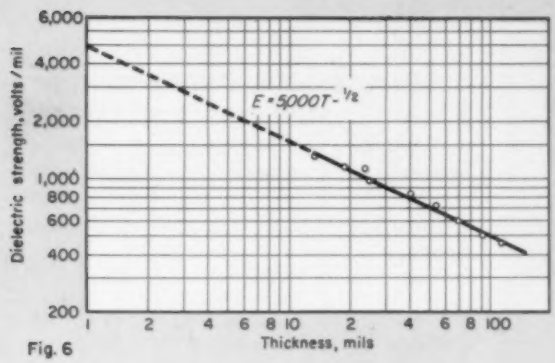

Fig. 6

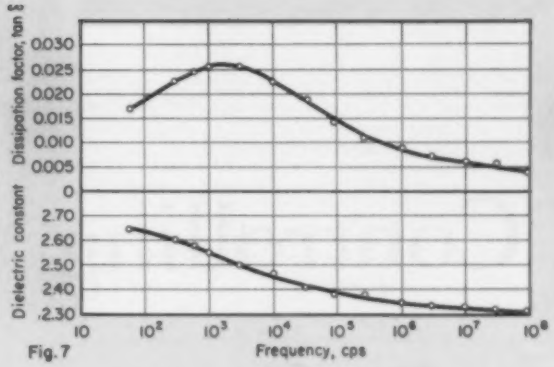

Fig. 7

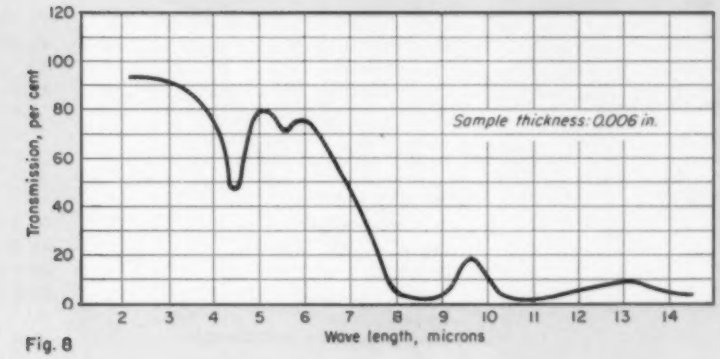

Fig. 8

Fig. 6—Dielectric strength of fluorothene. Electrical properties of this material are superior to most plastics.

Fig. 7—Dissipation factor and dielectric constant of trifluorochloroethylene vs temperature. Dielectric constant in the VHF and UHF range compares favorably with other leading dielectrics.

Fig. 8—Transparency of Kel-F wave lengths in infrared spectrum.

conducted by Bakelite Company have indicated the following values for insulation resistance: at 87 F, 22 gage wire with a 7-mil coating—30,000 megohms/1,000 ft.; at 194 F—10,000 megohms/1,000 feet.

Corona formation and surface flashover are minimized since the material has zero moisture absorption and resists wetting by water. Electrical properties, Fig. 6, are superior to most plastics. The presence of chlorine, which introduces a dipole moment, only affects electrical properties in the VHF and UHF range. However, the dielectric constant in this range compares favorably with other good dielectrics. The effects of temperature, and frequency, are shown in Fig. 7.

Chemical and Physical-Chemical Properties. Rigid trifluorochloroethylene exhibits excellent resistance to all chemicals ranging from strong oxidizing agents such as nitric acid and liquid chlorine to strong solvents. Some aromatic and halogenated organic compounds tend to swell it slightly.

The moisture absorption of trifluorochloroethylene is virtually nil. Water-vapor transmission is so low that the accuracy of measurements of this quantity is questionable. Polyethylene is considered an excellent barrier to water, but trifluorochloroethylene is much superior. Table II.

Table II—Fluid Transmission Properties of Trifluorochloroethylene and Other Thermoplastics

Material	Water Transmission Rate, gm/sq in./24 hr	Other Fluids	Loss, gm/100 in.·/24 hr/mil*
Unplasticized trifluorochloroethylene	0.1–1.0	Ammonia	0.02
Polyethylene	10	Methanol	0.02
Plasticized PVC	100–200	NaOH (50%)	0.03
		Bromine	0.10

* 10 mil trifluorochloroethylene film, heat sealed in bags, stored two weeks at 25C.

Optical Properties. Trifluorochloroethylene is colorless and can be made transparent or translucent to visible light as desired. Its use as a window material is based on its transparency to normal wave lengths as well as those in the infrared spectrum, Fig. 8.

Acknowledgements: The author acknowledges the assistance and cooperation of engineers of North American Aviation, Inc., the Union Carbide and Carbon Corporation, and the M. W. Kellogg Company, in the preparation of this article. The words "Teflon," "Kel-F," and "Bakelite," are registered trademarks of E. I. du Pont de Nemours & Co., The M. W. Kellogg Company, and Union Carbide and Carbon Corporation, respectively.

Controlling Radiant Heat

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Liaison Engineering Department
Westinghouse Electric Corporation

Table I—Emissivity of Various Materials

Material	Condition	Temp F	Emissivity, per cent
METALS			
Brass	Rolled plate	72	6.0
	Rubbed with emery	72	20.0
Copper	Commercially polished	66	3.0
	Oxidized by prolonged heating	77	78.0
Cast iron	Newly turned	72	43.5
Nickel-electroplated on iron	Not polished	68	11.0
	Polished	74	4.5
Lead	Grey oxidized	75	2.8
Silver	Polished	100	2.2
NON-METALS			
Asbestos-board		74	96.0
Glass	Smooth	72	94.0
Wood	Planed oak	70	90.0
Rubber	Hard glossy plate	74	95.0
Lampblack and water glass		70	95.0

Absorption and emission — (1) are essentially surface phenomena, (2) vary with finish-coating thickness and material, (3) vary with wavelength of heat energy, and (4) are relatively unaffected by finish color.

RADIANT HEAT absorbed or emitted by any material can be effectively influenced by the choice of surface finish. Some finishes possess the property of being "selective"; and their absorption characteristics may change as much as 80 per cent according to the wavelength of the incident radiation, the wavelength being dependent on the temperature of the emitting body. By giving proper consideration to all aspects of radiant-heat transfer as well as to problems of corrosion protection and appearance, *surface finishing* can be a very useful design tool.

An example, where choice of surface finish is used to good advantage to influence heat absorption, is in the design of a new waffle iron. A gray coating applied to the surface facing the heating element increases heat absorption, causing the waffle iron to reach cooking temperature 30 per cent faster than its predecessor. One "selective" absorber is common to everyday experience. The wearing of white clothing in summer keeps the body cooler, not only because the white cloth is a good reflector of the sun's heat rays (poor absorber for short wavelength radiation) but also because the same material excells in its ability to absorb and emit heat from the body (long wavelength radiation). Among innumerable devices where heat absorbing or reflecting surfaces are important, are thermal control elements, transformers, capacitors, jet engines, and electronic-tube components.

CONTROL PRINCIPLES

Heat can be transferred in three ways, of which *radiation* is one. (The other two are conduction and convection.) In most practical applications more than one is involved; therefore, it should be kept in mind that any one of the three may overshadow the others. Even when considering radiation alone, other factors must be taken

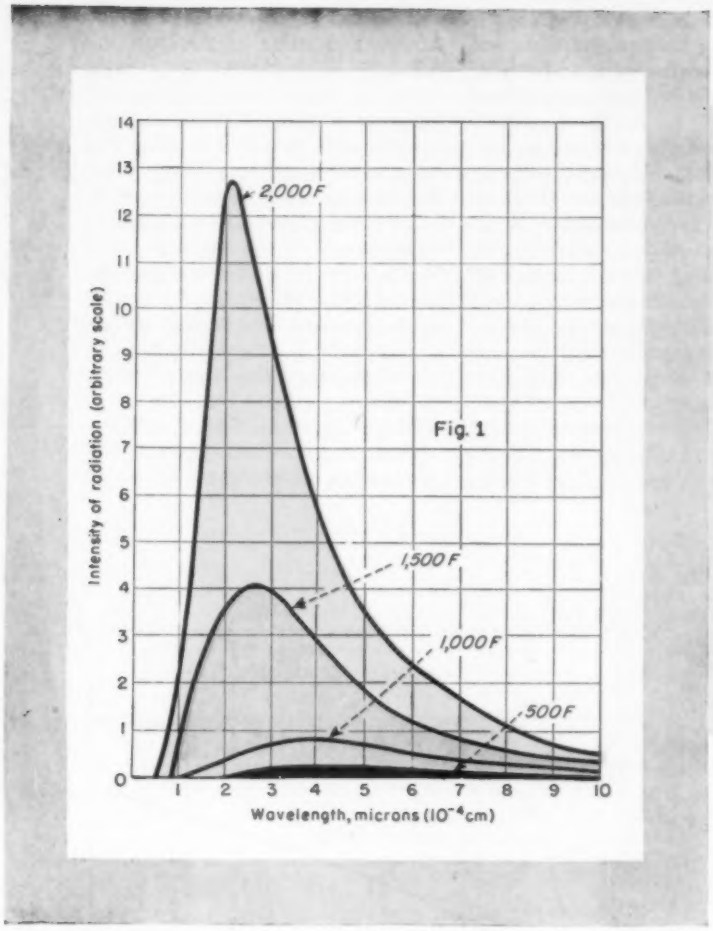


Fig. 1—Black-body radiation distribution curves for different temperatures. Note that higher temperatures increase maximum intensity of radiation and decrease the wavelength of this maximum.

Table II—Emissivity of a Few Pigments*

Pigment	Emissivity in per cent at the following wavelengths in microns				
	24	8.8 (125 F)	4.4 (750 F)	0.95 (5,000 F)	0.60 (Solar)
Champhor soot	94	98	99	—	99
Lampblack	—	94.5	94.5	—	—
Black (CuO)	96	——	85	76	—
Yellow (PbO)	90	74	49	—	48
White ($PbCO_3$)	93	89	71	8	12
White (Al_2O_3)	94	98	79	12	16
White (ZnO)	95	97	91	14	18

* *See reference 3*

into account, such as the continuous transfer of radiant energy from a body to and from its surroundings. For example, the feeder pipes to a domestic hot-water heating system radiate heat to the walls of a basement. Although the walls are at a lower temperature than the pipe, they also radiate heat, a certain portion of which is absorbed by the feeder pipes. Calculation of the net loss in heat radiation[1], therefore, requires consideration of the temperature of both the wall and the pipe as well as the ability of each to absorb and emit radiant heat.

Surface absorptivity is a measure of the ability of a material to absorb radiant heat. A theoretical "black body" absorbs all incident radiation at all wavelengths and reflects none. Although a perfect black body does not exist, some surfaces—such as those coated with lampblack—reflect such a small portion of any incident radiation that they approach ideal black-body conditions. A good heat-absorbing surface is, at the same time, a good emitter of heat energy (loss of heat by outgoing radiation) at the same wavelength. *Emissivity* is the term used to define the ability of a surface to emit radiant heat. By definition, the emissivity of a surface is the ratio of radiation from that surface to the radiation from a black body under the same conditions of wavelength and temperature. For example, a surface of lampblack mixed with water glass has an emissivity of approximately 95 per cent of a perfect black body. In contrast, a commercially polished copper surface at about the same temperature has negligible emissivity or only about 3 per cent of that for a perfect black body. Some other examples are given in Table I. (The term "emissivity" used in the tables, not only denotes the ability to emit but also to absorb or reflect radiant heat.)

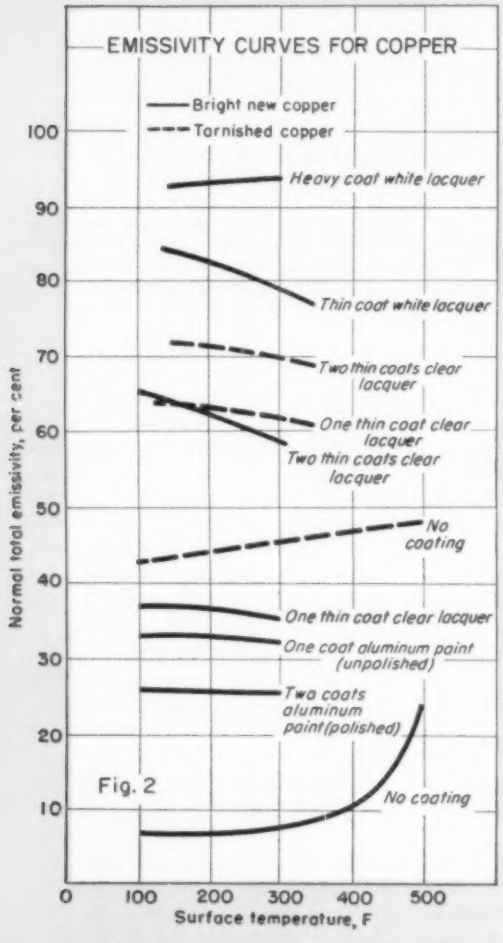
The intensity of radiation of any surface varies with the wavelength and temperature. A few black-body radiation distribution curves for different temperatures are shown in Fig. 1. The area under each curve represents the total spectral energy emitted at the temperature indicated. Increasing the temperature causes an increase in the intensity of radiation at any given wavelength and a decrease in the wavelength at which maximum energy emission occurs. Lampblack gives similar emission curves.

In general, the emission curve for any practical surface lies below that for a black body at the same temperature. Some materials respond quite differently to radiant heat than a black body. They are "selective" in their ability to absorb, and this ability varies widely at different wavelengths. White cloth is a poor absorber of radiation

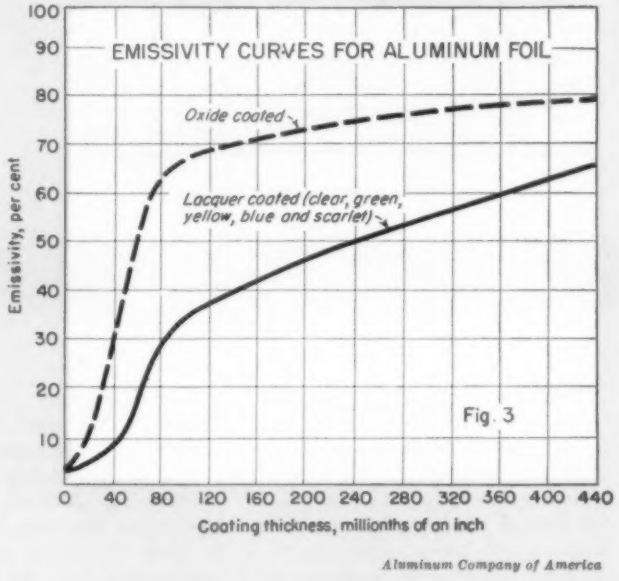
from the sun (low emissivity at short, high-temperature wavelengths), and at the same time is a good emitter of body heat (high emissivity at long, low-temperature wavelengths). The coolness of white clothing in summer, therefore, can be ascribed not only to its low absorptivity of solar radiation but also to its high absorptivity of body heat which is re-emitted to the surroundings at a rapid rate.

Zinc oxide (ZnO) is also selective as shown in Table II (last item). Its emissivity, although 97 per cent at a temperature of 125 F (corresponding to a wavelength of 8.8 microns), is only 14 per cent at 5,000 F (0.95 microns), and 18 per cent at solar temperatures (0.60 microns). An emissivity value at a given temperature does not necessarily mean that the body itself is at that temperature; instead, it may indicate the ability of the body to absorb radiant heat from a second body operating at that temperature.

Two important considerations in dealing with radiant-heat absorption and emission problems are: (1) for most solids, absorption and emission are surface phenomena; and (2) the color of a surface is not a measure of its ability to absorb or radiate heat. For example, bright copper has an emissivity of approximately 7 per cent at 200 F and 44 per cent if the surface is tarnished, as shown in Fig. 2. These same curves show that the emissivity of bright copper can be increased from 7 to 37 per cent merely by applying a thin coat of clear lacquer. The effect of various thicknesses of lacquer and oxide coatings on the emissivity of aluminum foil is shown in Fig. 3. A thin coating of aluminum oxide on aluminum foil can change the emissivity from 3 per cent to a value as high as 80 per cent. Note that the thickness of the oxide coating becomes less effective after a value of approximately 70 per cent is attained. Experiments have shown that the emissivity of polished iron (0-100 F) can be increased to as high as 83 per cent by applying a very thick layer of oil. These data[2] show that a 0.0008-in. thick layer of oil results in an emissivity of 22 per cent and that a 0.008-in. layer of oil increases the emissivity to 81 per cent. Curves of



Data from curves by R. H. Heilman



Aluminum Company of America

Fig. 2—Striking increases in emissivity can be obtained by choice of a surface finish for copper. Curves for bright and tarnished copper relate normal total emissivity to surface temperature.

Fig. 3—Curves showing effect of organic dyed lacquer and oxide coatings on emissivity of aluminum foil. Note that color or finish has negligible effect on emissivity; also, that there is an optimum thickness of coating beyond which little gain in emissivity occurs.

emissivity vs temperature for samples of Nichrome V are shown in Fig. 4. The same curves[10] show the effect of preoxidizing the samples prior to testing.

Dead black, black, black enamel, dark green, white, and white enamel paints all have practically the same emission characteristics when coated on a material operating at about 100 C[3]. This is why the efficiency of a steam radiator painted with conventional household paints is equally good regardless of color. Yet, when considering such finishes as aluminum and bronze-colored metallic pigmented paints, lacquers, etc., the situation is somewhat different. Since most metallic pigmented finishes have emissivity values considerably lower than standard household paints, a household hot-water or steam radiator painted with aluminum paint might be expected to be less efficient than one painted with enamel. Actually, the net difference in efficiency may be negligible, or in some instances in favor of the lower emissivity finish. Approximately 70 per cent of the heat dissipated[4] from a two-column radiator of thirteen sections is transferred to the room by convection, whereas 30 per cent is dissipated by radiation. Radiant heat is mainly useful to the object upon which it impinges and is generally lost to the walls, ceiling, etc. A low emissivity finish on the radiator could therefore decrease the amount of heat radiated directly to the inside walls and subsequently lost to the outside walls by conduction. Another variable results from the fact that the emissivity of metallic paints can be varied by the degree of leafing (arrangement of particles), which is dependent (among other considerations) on the physical size and shape of the metallic particles as well as the composition of the vehicle used to carry the metal. For example, an aluminum paint* consisting of aluminum powder and a low-solids-content varnish might have an emissivity as low as 25 per cent; on the other hand, an aluminum paint with an emissivity as high as 60 per cent can be made with aluminum paste (extremely fine powder mixed with liquid) and a suitable varnish. An excess of resin, or an extra coat of clear resin or laquer on the surface, further increases the emissivity.

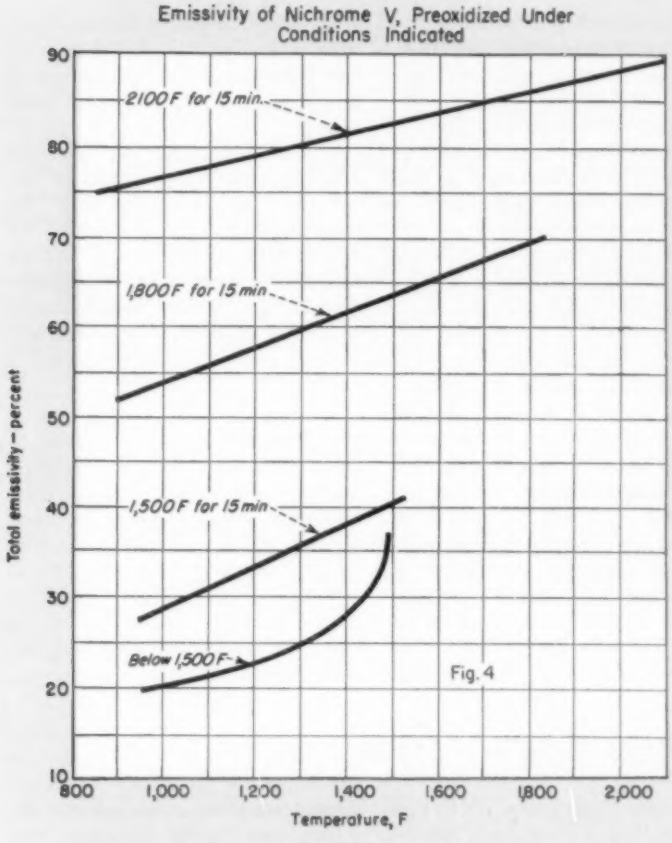


Fig. 4

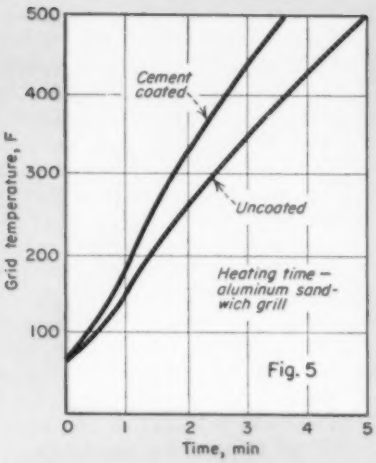
Fig. 4—These curves for samples of Nichrome V illustrate the effect of preoxidation at different temperatures. Bottom curve has no preoxidizing treatment except that incurred during the test. Significance is that an initially nonoxidized surface may change emissivity characteristics under temperature, resulting in considerable change in operation of the device in which the metal is used. (See reference 10).

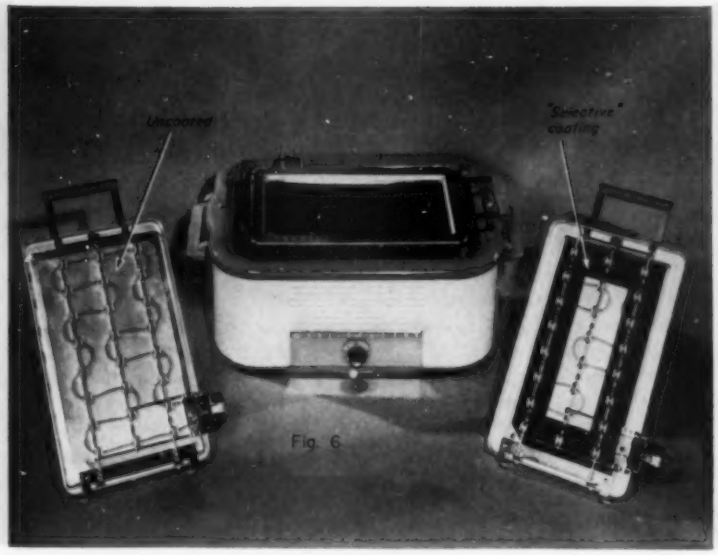
Data for the lacquer-coated aluminum curve in Fig 3 substantiates the fact that color is not a criterion for predicting emissivity. The increase in emissivity of aluminum foil resulting from application of various thicknesses or organic dyed lacquers, is essentially the same for clear, green, yellow, blue and scarlet colors. However, lacquers pigmented with such materials as zinc oxide, lead oxide, or lampblack may show an entirely different "thickness vs emissivity" relationship.

A highly polished surface is commonly assumed to have low emissivity —a roughened one, appreciably higher. For extreme roughening, this is true; but roughening of aluminum to an extent that the specular reflecting characteristics are destroyed, increases the emissivity only 3 per cent[9].

The behavior of all materials in respect to emissivity vs temperature cannot be explained by one simple law. Experimentation and comparison with similar material compositions have established the actual radiation and absorption characteristics of many surfaces; however, such information is understandably not available for every material nor for all temperatures. Therefore, it is often necessary in practical applications to measure the emissivity of a test panel. Various methods are available for accomplishing this[9, 10].

** Aluminum paints are pigmented with high-purity aluminum, although they are sometimes referred to as "aluminum bronze" pigments. The pigment is generally in flake form for both powder and paste, and in some cases the largest cross section of the flake is 200 times the thickness.*





APPLICATIONS

Among innumerable devices where heat absorbing or reflecting surfaces are important, are thermal control elements, transformers, capacitors, jet engines, and electronic-tube components. The following typical applications demonstrate how careful selection of surface can help solve many radiation design problems.

Jet Engines. One means of lowering the combustion-wall temperature in jet engines is to maintain low emissivity of the surface facing the combustion gases while increasing the emissivity of the outer wall[10]. The low-emissivity inner surface minimizes the amount of radiant heat absorbed by the combustion wall, and the high-emissivity outer surface facilitates the dissipation of whatever heat *is* absorbed. Ceramic finishes have been developed that can raise the emissivity of combustor materials to over 90 per cent at temperatures of 800 to 1,100 F.

Waffle Iron and Sandwich Grill. A combination waffle iron and sandwich grill for home and restaurant use employs an aluminum cooking surface which is heated by radiation from resistance coils beneath the plate. The time to reach cooking temperature has been decreased by 30 per cent (from 5 to 3½ minutes) merely by increasing the absorptivity of the surface facing the heating element. This also lowers the cost of operation for the consumer. The emissivity of the grid can be increased by anodizing or by applying a surface coating to the aluminum. However, a recent design uses a cement mixture applied by spraying, that stands up under high temperatures and has an emissivity of approximately 90 per cent. The improvement in performance is shown graphically in Fig. 5.

Large Area Cooking Grills. The problem of obtaining uniform heat distribution on a large grill has been solved by selectivity coating the bottom surface of the grill to increase the emissivity at desired locations, as shown in Fig. 6. Without the heat absorbing finish around the bottom of the grill, the center would operate at a higher temperature than the edges.

Toasters. Thermal voltage-control regulators for toasters become more efficient when using controlled heat-absorption surface finishes for the bimetals. These finishes increase the reaction speed of the thermostat. In addition, they prevent the thermostat from losing calibration, as often occurs when an untreated bimetal element becomes dirty or oxidized during normal use, with resultant increase in emissivity.

One finish used for this purpose is a lacquer containing mixtures of silicone resin, mica, and carbon black. This material stands up well under the flexing action of the bimetal, and the treated surface has an emissivity greater than 90 per cent at temperatures to which it is exposed. The treatment is shown applied to the toaster bimetal in Fig. 7.

Another satisfactory treatment is obtained by electroplating of finely divided metal and oxide. These electrodeposits[11] are basically metallic chromium, containing vanadium or nickel or both, and can be applied to most metals without special equipment. In addition to high emissivity characteristics, these deposits adhere well to the base metal and offer good heat and chemical resistance.

MULTIPLE BENEFIT APPLICATIONS

In certain applications of finishes for controlling radiant heat, two or more engineering advantages are gained simultaneously. Following are several such examples:

Electronic Tubes. The carbonized nickel surface used on some vacuum-tube anodes in receiving and industrial electronic tubes, results in a high thermal emissivity coating which dissipates heat, thereby reducing "back electron" or secondary electron emission. The back electron emission is further reduced[12] by tendency of the carbon to entrap any barium sublimed from the filament coating to the anode, thus rendering the barium inactive as an electron emitter.

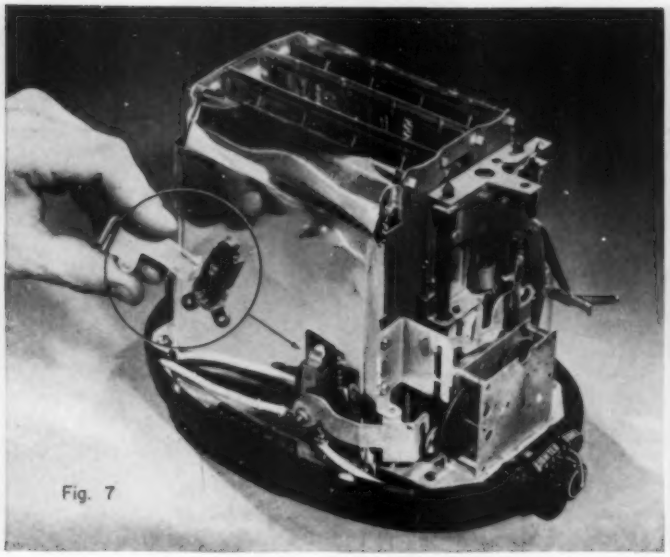


Fig. 5—Effect on heating time of aluminum sandwich grill by application of cement coating to the bottom of grill.

Fig. 6—By coating underside of this large-surface cooking grill "selectively," the emissivity is increased at desired areas, providing uniform heating over entire surface.

Fig. 7—Toaster bimetal element is coated with a lacquer to control heat absorption. This gives the surface of the element an emissivity of greater than 90 per cent at temperatures to which it is exposed. Thermal reaction is thus more rapid, and calibration is maintained indefinitely.

Many applications may be found for aluminum-clad steel treated in similar manner to that often now being used for vacuum-tube parts[13, 14]. When steel is clad with aluminum and subsequently heated to about 650 C for a time, the two metals diffuse with resultant conversion of the surface to compounds of iron and aluminum. A rough, black surface results which has a thermal emissivity of 80 to 85 per cent. Tube parts, such as anodes and shields, have been prepared in this manner. In addition to possessing the property of high thermal emissivity, indications point to the fact that they can be more completely outgassed faster than can some other materials[14] and with apparent reduction in gas evolution during life. This blackening effect can be produced[13] by vacuum evaporation of aluminum on iron. Other combinations of metals, such as nickel-iron and molybdenum-iron, give similar effect.

Electromagnets. The focus coil construction for some television sets is in the form of a doughnut-shaped electromagnet enclosed in a metal case. The original finish, which was selected primarily for corrosion protection, resulted in the coil operating at a temperature of around 54 C. Treating the surface with a black oxide finish cuts the operating temperature down to about 36 C. The higher temperature would have caused an increase in time for the focus control to become stabilized.

Transformers. Finishes on some types of transformers serve a dual purpose by providing emissivity and absorptivity control as well as corrosion protection. For such applications, heat dissipation by convection may overshadow radiant-heat transfer. For example, a wind velocity of a few miles per hour may offset the effect of solar radiations[15] impinging on an outdoor transformer. In this case, a high-emissivity surface to dissipate the heat may be more important than a highly reflecting (low emissivity) surface to ward off the solar radiation.

Capacitors. Outdoor capacitors are heavily metallized with zinc to prevent rusting of the cases over long periods of weather exposure. The freshly metallized surface does not radiate the losses as well as the previous painted finishes since the emissivity of freshly sprayed zinc is low. Therefore, a finish coat of a high-emissivity lacquer is applied to reduce the operating temperature and at the same time provide some added corrosion protection and better appearance.

Material for this article is based in part on information supplied by Westinghouse Operating Divisions and Research Laboratories.

REFERENCES

1. Stoever, Herman J., *Applied Heat Transmission,* McGraw-Hill Book Co., Inc., 1941, p. 27.

2. Fishenden, M. and O. A. Saunders, *Heat Transfer,* Oxford University Press, Amenhouse, London E.C. 4, Eng., 1950.

3. Fishenden, M. and O. A. Saunders, *The Calculation of Heat Transmission,* H. M. Stationery Office, London W.C. 2, England, 1932.

4. Coblentz, W. W. and C. G. Hughes, "Emissive Tests of Paints for Decreasing or Increasing Heating Radiation from Surfaces," *Technological Papers of Bureau of Standards,* Vol. 18, No. 254, 1924, pp. 171-87.

5. Jakob, Max, *Heat Transfer,* John Wiley & Sons. Inc., 1949, pp. 23-58.

6. McAdams, William H., *Heat Transmission,* McGraw-Hill Book Co., 1942.

7. Eckert, E. R. C., *Introduction to the Transfer of Heat and Mass,* McGraw-Hill Book Co., Inc., 1950.

8. Marks, Lionel S., *Mechanical Engineers Handbook,* McGraw-Hill Book Co., Inc., 1947.

9. Taylor, C. S. and J. D. Edwards, "Some Reflection and Radiation Characteristics of Aluminum," *Transactions of the American Society for Heating and Ventilating Engineers,* Vol. 45, 1939, pp. 179-94.

10. DeCorso, S. M. and R. L. Coit, "Measurement of Total Emissivity of Gas Turbine Combustor Materials"; scheduled for presentation at 1954 Semiannual Meeting of the ASME (pre-print No. 54-SA-26).

11. Quaely, Martin F., "Black-Chromium Base Electroplating," *Plating,* Vol. 40, September 1953, pp. 982-6.

12. Briggs, T. H., "Carbonized Nickel for Radio Tubes," *Metals and Alloys,* November 1938, pp. 303-7.

13. Espe, W. and E. P. Steinberg, "Aluminum-Clad Iron for Electron Tubes," *Tele-Tech,* February 1951, p. 28.

14. Hase, A. P. and E. P. Fehr, "New Vacuum Tube Materials," *Tele-Tech,* July 1951, pp. 33-5.

15. Penny, G. W., "Temperature Rise of Electrical Apparatus as Affected by Radiation," *AIEE Transactions,* Vol. 59, 1940, pp. 338-42.

TYPICAL EXAMPLE of a critical component designed as a hollow cylinder, is the shaft of this turbine assembly of the Rolls-Royce "Dart" turbo-propeller engine. About 4500 HP at 14,500 RPM is transmitted through the shaft to the propeller from the turbine. Four "Dart" engines are used to power the Vickers Viscount airplane.

J. J. EDEN
Senior Engineer, Trans-Canada Airlines

Graphical Method of Designing

Thin-Wall Cylinders

Components that are equivalent to hollow cylinders are usually designed by successive approximations when both strength and weight are critical. This is time-consuming and cumbersome. Thus, these nomographs were developed to quickly pinpoint combinations of dimensions that satisfy both cylinders subjected to torsion and to bending. Their accuracy is adequate for all but the most precise calculations.

I—CYLINDER IN TORSION

A hollow thin-wall cylinder that is subjected to torsion can fail either from material failure or from elastic instability. The shear stress produced in such a cylinder is given by:

$$S_Q = \frac{QR}{I_p} = \frac{QR}{2\pi R^3 T} = \frac{Q}{2\pi R^2 T} \quad (1)$$

Depending upon the properties of the material at the operating temperature of the cylinder and the required safety factor, a maximum allowable shear stress, S_A, will be chosen and the cylinder will then be designed for the condition

$$S_A = S_Q = \frac{Q}{2\pi R^2 T} \quad (2)$$

A nomogram of Eq (1) is given in Fig. 2. From this, and a given applied torque and given cylinder dimensions, the resulting working shear stress can be determined. Conversely, limiting the allowable shear stress, the required cylinder dimensions can be evaluated for a given value of torque.

The relationship between the critical shear stress at which buckling will occur and the dimensions for steel cylinders was previously established (Ref. 1) as:

$$S_B = 2.265 \times 10^7 \frac{T^{5/4}}{L^{1/2} D^{3/4}}$$

$$S_B = 1.348 \times 10^7 \frac{T^{5/4}}{L^{1/2} R^{3/4} t} \quad (3)$$

A nomogram for the above equation was constructed in this reference from which the elastic stability can be determined.

A cylinder that satisfies Eqs (2) and (3) should not fail under the imposed loading. However, both these equations can be satisfied by any number of combinations of dimensions, yet only one of these will be the combination giving a cylinder of minimum weight.

The weight of the cylinder is

$$W = 2\pi R T L \rho \quad (4)$$

For the design of the cylinder two limiting conditions are possible:

SYMBOLS

S_Q	Working shear stress due to torsion, Q, psi
S_A	Maximum allowable shear stress, psi
S_B	Critical buckling stress due to torsion, psi
S_M	Stress due to bending moment M, psi
S	Maximum allowable working stress, psi
S'	Critical buckling stress due to bending, psi
Q	Torque applies to cylinder, in-lb
M	Bending moment applied to cylinder, in-lb
I_p	Polar moment of inertia, in.^{4}
I_z	Moment of inertia of cylinder, in.^{4}
D	Mean cylinder dia, in.
R	Mean cylinder radius, in.
R_o	Outside cylinder radius, in.
R_i	Inside cylinder radius, in.
T	Cylinder wall thickness, in.
L	Cylinder length, in.
W	Weight, lb
ρ	Density, lb/in^3
ϵ	Poisson's ratio
E	Modulus of elasticity, psi

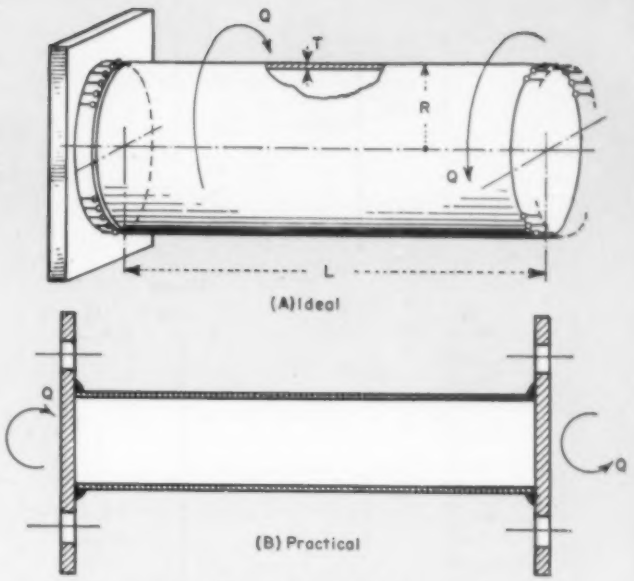


Fig. 1—Thin cylinder in torsion (A) shows ideal end conditions; (B) shows practical construction that approaches this ideal. Equations and graphs herein are generally applicable to steel cylinders of any thickness and end conditions. In extreme case, accuracy is 10 per cent on safe side.

1. The allowable shear stress is the criterion limiting the design:

From Eqs (1) and (4),

$$W = \frac{2\pi RQL\rho}{2\pi R^2 S_Q} = \frac{QL\rho}{RS_Q}$$

Since the torque, cylinder length and material density are generally given and constant, the weight varies inversely as the radius and the working stress. Thus, to obtain a cylinder of minimum weight it must be designed to the maximum allowable stress, S_A, and to the maximum possible radius.

Designing to a maximum cylinder radius will cause the cylinder thickness to be a minimum. The extent to which the thickness can be reduced is limited by production requirements and by the elastic instability of the structure.

The limitation on the thickness because of available or selected methods of manufacture must be determined first, since this may well be the critical factor. The design is then checked for instability.

2. The elastic instability is the criterion limiting the design:

From Eq (3):

$$T^{5/4} = \frac{1}{1.348 \times 10^7} S_B L^{1/2} R^{3/4}, \text{ or}$$

$$T = 7.42 \times 10^{-6} S_B^{4/5} L^{2/5} R^{3/5}$$

Substituting for T in Eq (4)

$$W = 4.66 \times 10^{-7} L^{7/5} \rho S_B^{4/5} R^{8/5}$$

For a constant cylinder length and material density,

$$W = (Constant)\, S_B^{4/5} R^{8/5}$$

The weight is a direct function of the buckling stress and the cylinder radius. Hence, to achieve a minimum weight in this case the buckling stress should be as close as possible to the working stress and the radius should be a minimum, resulting in a maximum thickness. This leads to a condition where the maximum allowable working stress is again the limiting criterion.

The requirements of the two limiting conditions are therefore conflicting. As long as the maximum allowable working stress is the limiting criterion a cylinder of minimum weight will be obtained by using the maximum allowable working stress and maximum radius. If this produces so thin a cylinder wall as to cause elastic instability, then to achieve minimum cylinder weight it is necessary to rearrange the various dimensions in such a manner as to make the maximum allowable working stress the critical limitation again.

To obtain the correct compromise between these requirements, a safety factor (buckling stress over working stress) of 1.2 is recommended. Thus, the optimum design must satisfy the condition

$$S_B = 1.2 S_Q \qquad (5)$$

Combining Eqs (1), (3) and (5),

$$S_Q^{9/4} = 1.125 \times 10^6 \frac{Q^{5/4}}{R^{13/4} L^{1/2}} \qquad (6)$$

A nomogram of Eq (6) is given in Fig. 3. From this, for a given torque, cylinder length and required working stress, the correct radius can be determined which will give a cylinder

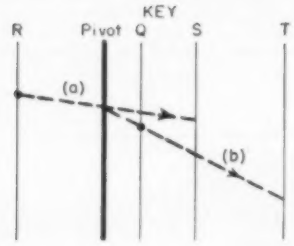
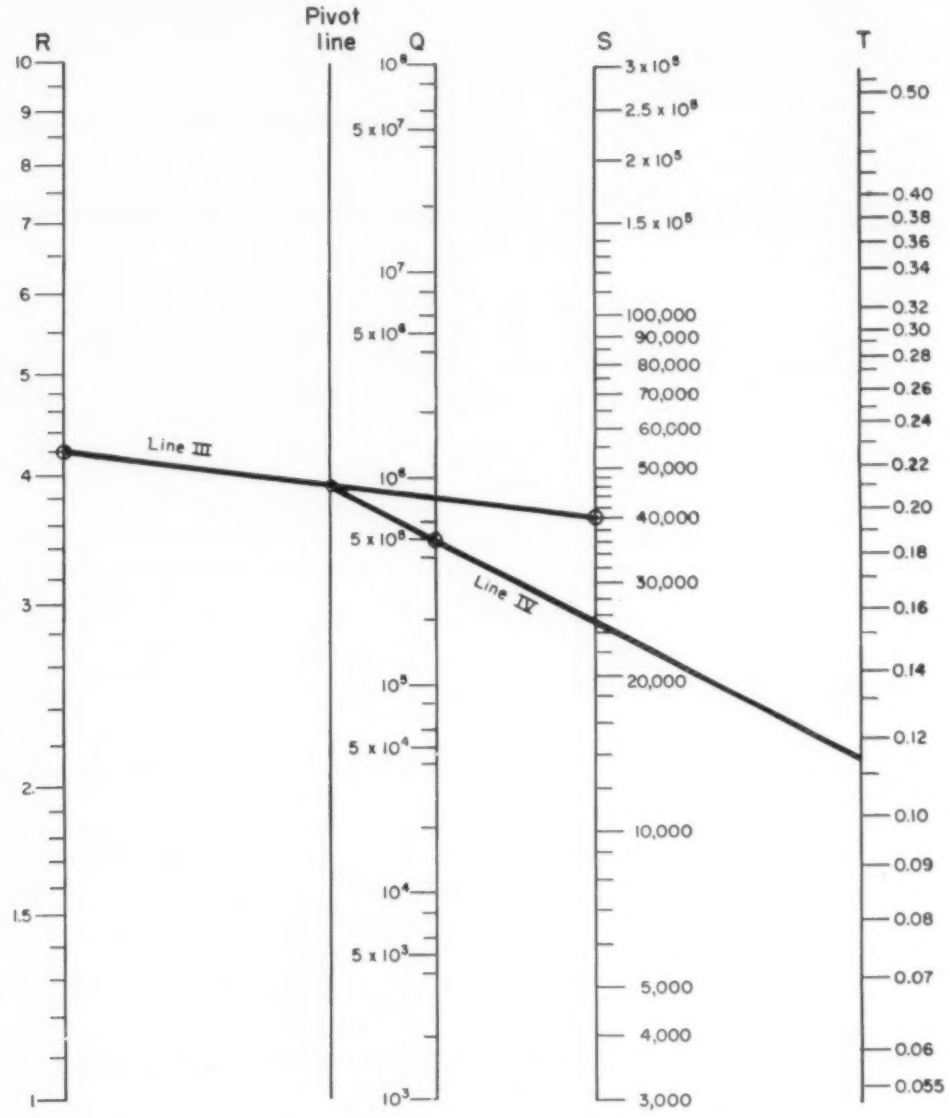


Fig. 2—Nomogram based on allowable shear stress as the design criterion.

$$S = \frac{Q}{2\pi R^2 T}$$



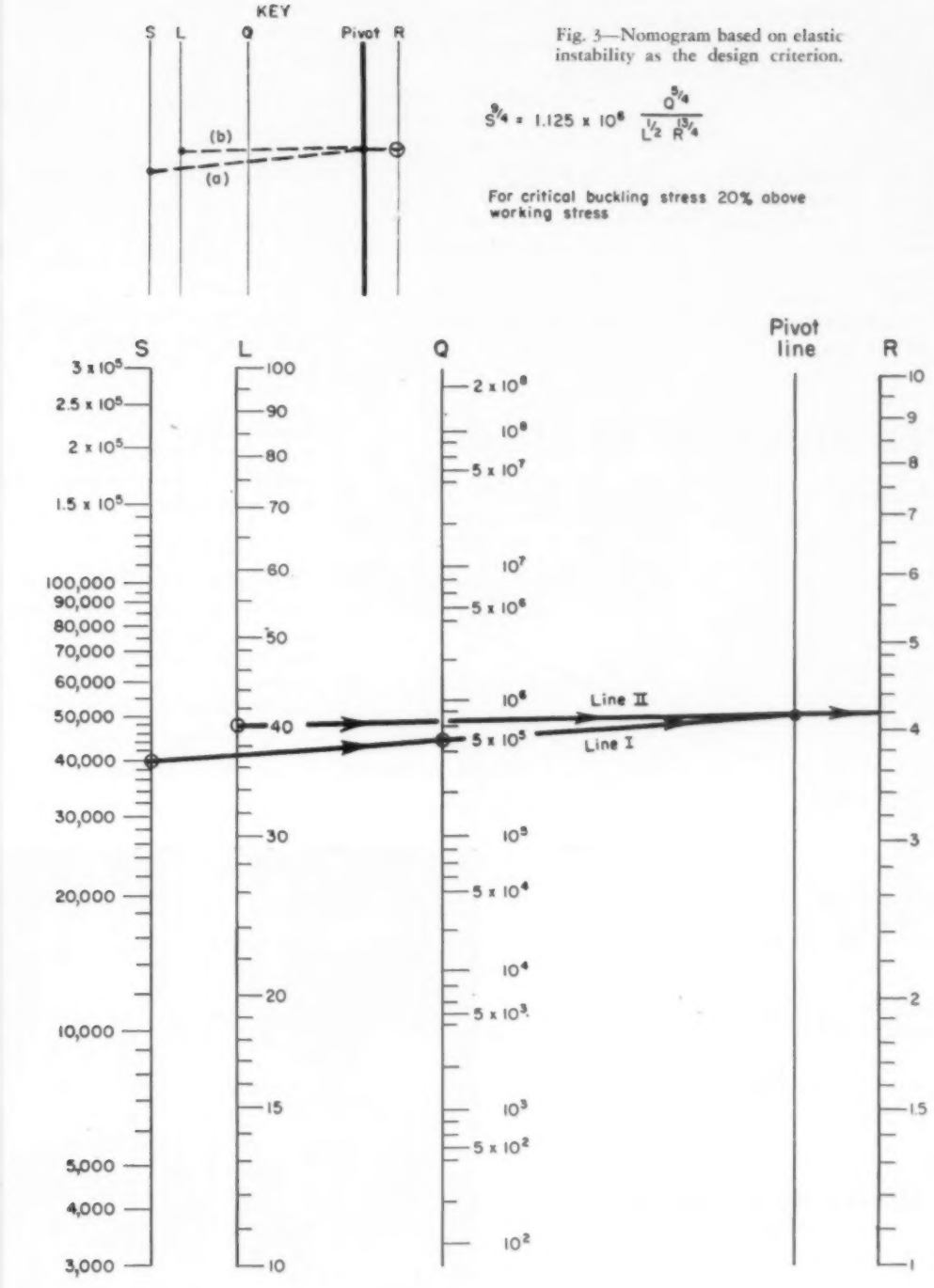


Fig. 3—Nomogram based on elastic instability as the design criterion.

of minimum weight. From Fig. 2, the corresponding required thickness can then be found.

Where a different safety factor of buckling stress to working stress is required, the stress used in Fig. 3 should be multiplied by the ratio of the required factor over that of 1.2, used in the nomogram.

EXAMPLE:

A machined steel cylinder of 40 in. length is to transmit a torque of 5×10^5 lb-in. and must pass through a casting with a maximum clearance of 5.25 in. radius. The maximum allowable working stress is 40,000 psi. The minimum wall thickness attainable with available equipment is 0.09 inch.

SOLUTION:

(a) Let the mean radius of the cylinder be 5 inches.

(b) From Fig. 1 for $S = 40{,}000$ lb/sq. in., $Q = 5 \times 10^5$ lb.-in., and $R = 5.0$ in., the corresponding thickness $T = 0.080$ in.

(c) Since this cylinder thickness is less than the minimum produceable thickness, 0.090 in. is used.

From Fig. 2, for $Q = 5 \times 10^5$ lb.-in. $R = 5.0$ in., and $T = 0.090$ in., the working stress $S = 35{,}300$ psi.

(d) From the nomogram of Reference 1 or Eq (3),

for $R = 5.0$ in., $L = 40$ in., and $T = 0.090$ in., the critical bulking stress $S_B = 31{,}000$ psi.

This is lower than the working stress; hence, the elastic instability is the critical factor of the design.

(e) From Lines I and II in Fig. 3, for $S = 40{,}000$ psi, $Q = 5 \times 10^5$ lb-in., and $L = 40$ in., the optimum design radius = 4.2 in.

(f) From Lines III and IV in Fig. 2, for $R = 4.2$ in., $S = 40{,}000$ lb/sq. in., and $Q = 5 \times 10^5$ lb-in., the corresponding thickness $T = 0.113$ in.

(g) The weight of the cylinder is, from Eq (4) (for steel: $\rho = 0.283$ lb/cu. in.):

$$W = 2 \pi \times 4.2 \times 0.113 \times 40 \times 0.283 = 33.8 \text{ lb.}$$

This is the minimum weight for the given loads and operating conditions.

II—CYLINDERS IN BENDING

In a similar manner, an optimum design procedure can be derived for hollow cylinders in bending.

When loaded as shown in Fig. 5, a hollow, thin-walled cylinder can fail either as a result of stresses exceeding the yield point of the material or because of elastic instability. The tensile or compressive stress produced by the applied bending moment is:

$$S_M = \frac{MR}{I_x} = \frac{M}{\pi R^2 T} \qquad (7)$$

Depending upon the properties of the material used at the operating temperatures of the cylinder and the required safety factor, a maximum allowable stress S is usually chosen and the cylinder is then designed for the condition

$$S \geq S_M = \frac{M}{\pi R^2 T} \qquad (8)$$

A graphical solution of Eq (7) is presented in Fig. 6. Given any three variables, the fourth can be derived from the nomogram.

A critical bending moment associated with cylinder buckling is given in Ref. 2 as follows:

$$M' = K \frac{E}{1 - \epsilon} R T^2$$

Experimental data show that K is a constant with a minimum value of 0.72 and an average value of 1.14. Using this average value, and assuming the material is steel, ($E = 3 \times 10^7$ and $\epsilon = 0.3$), the above equation reduces to:

$$M' = 3.75 \times 10^7 R T^2 \qquad (9)$$

The critical buckling stress corre-

Fig. 4—Undercarriage of "North-Star" airliner, showing the hollow main cylinder which is illustrative of thin-wall cylinders subject to bending.

Fig. 5—Ideal (A) and practical (B) schematic diagrams of thin-wall cylinders in bending. Latter is a guided missile with aerodynamic loads.

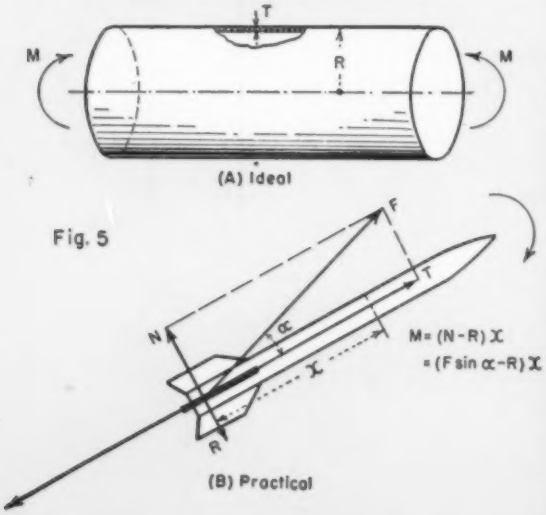


Fig. 5

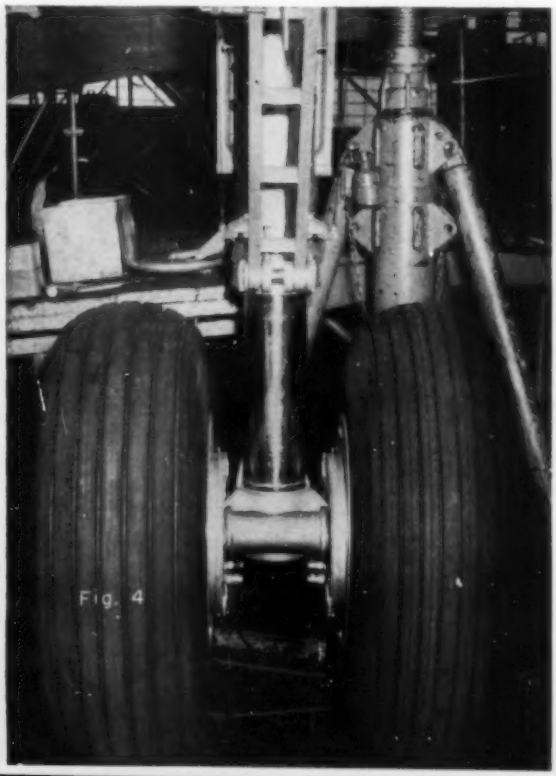
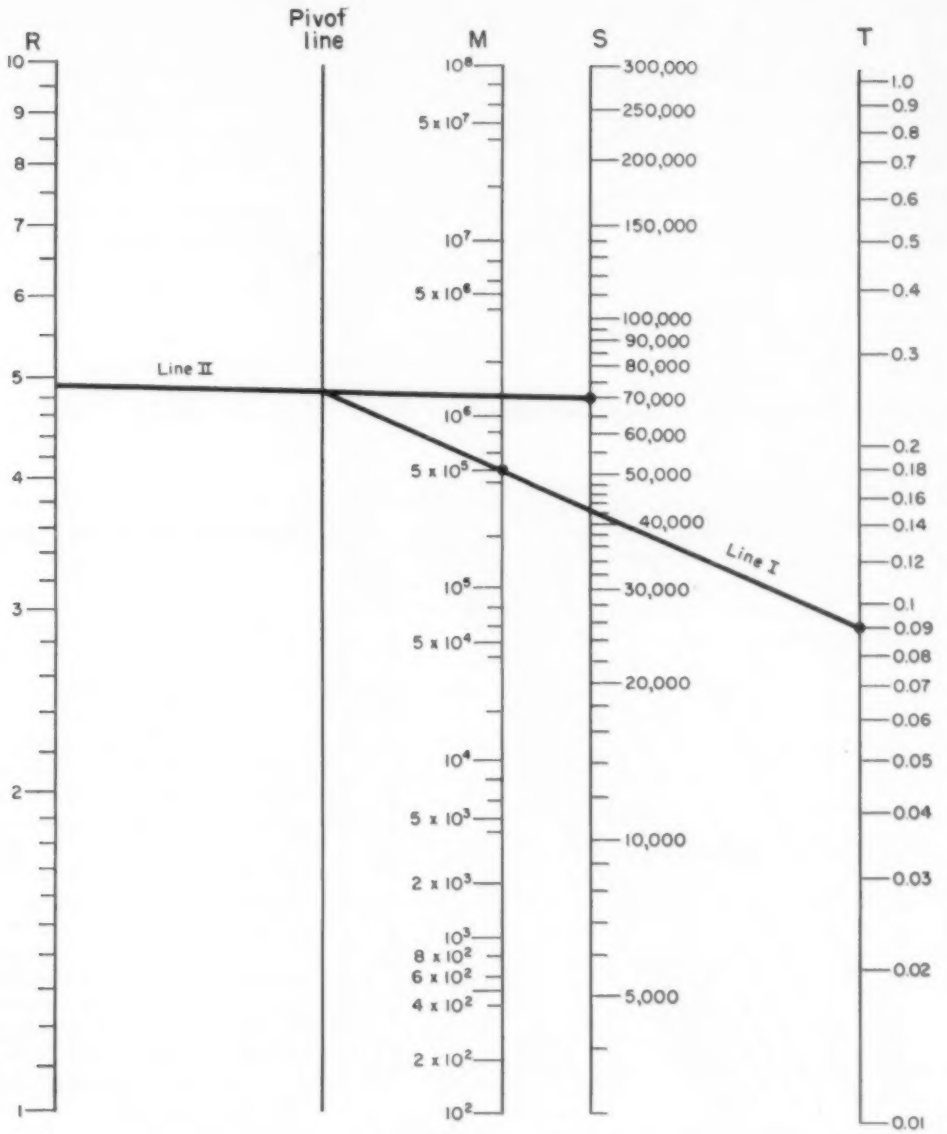


Fig. 4

$$S = \frac{M}{\pi R^2 T}$$

Fig. 6—Nomogram for bending stress in cylinders.

Example: Given: T = 0.09 in.-lb
M = 5 x 10^5 in-lb
S = 70,000 psi
Solution: R = 4.9 in.



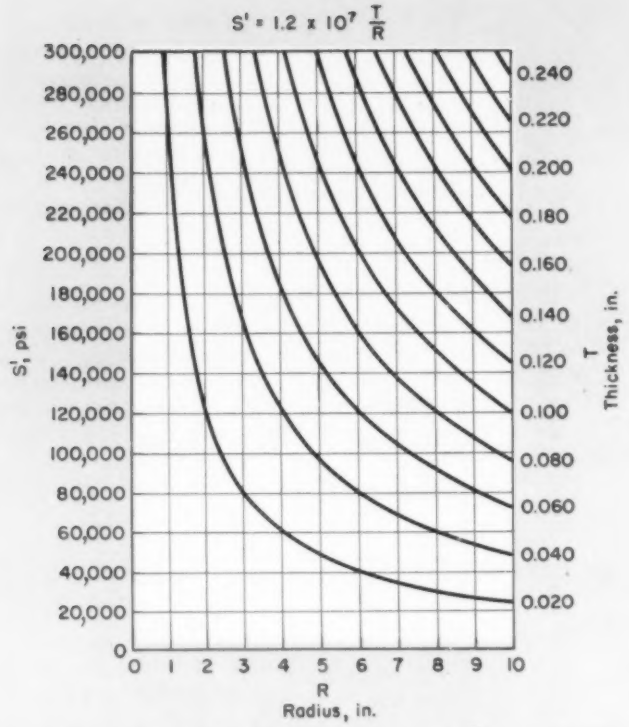


Fig. 7—Nomogram for critical buckling stress given by Eq (10).

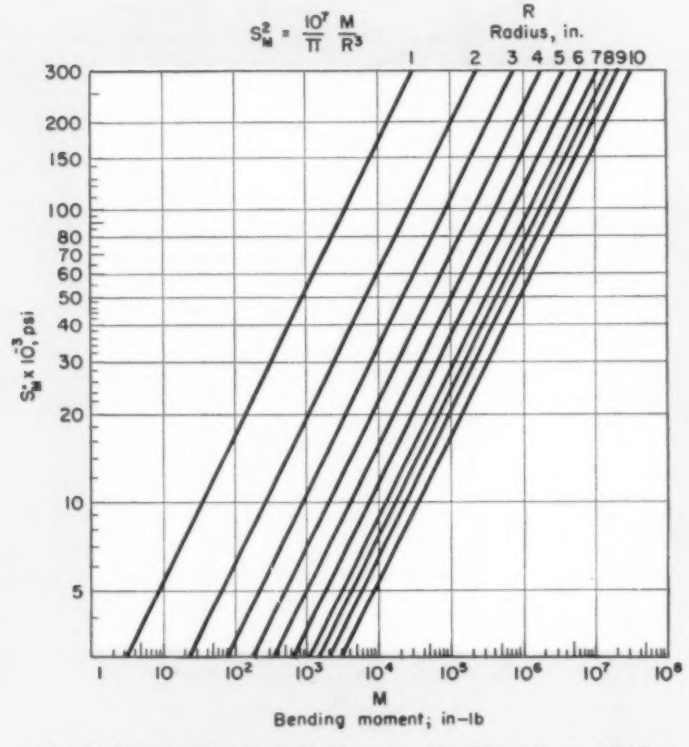


Fig. 8—Nomogram for Eq (12). For a given bending moment and allowable stress, the radius for minimum cylinder weight can be found.

sponding to the critical bending moment is:

$$S' = \frac{M'}{\pi R^2 T} = \frac{3.75 \times 10^7}{\pi} \frac{RT^2}{R^2 T}$$

or
$$S' \leqq 1.2 \times 10^7 \frac{T}{R} \qquad (10)$$

With the graphical solution of Eq. (10) given in Fig. 7, it is possible to obtain the critical stress for a given radius and thickness. Conversely, for a limiting given stress and one dimension, the unknown dimension, is obtained.

If a cylinder is designed to satisfy both Eqs. (8) and (10) it should not fail under the imposed bending moment. However both of these equations can be satisfied by any number of combinations of radius and thickness. But for a given bending moment and limiting stress there will be only one combination giving the minimum weight.

The weight of the cylinder is given by

$$W = 2\pi RTL\rho \qquad (11)$$

Two limiting conditions may exist for the cylinder design:

1. The allowable stress is the limiting criterion; From Eq (7),

$$T = \frac{M}{\pi R^2 S_M}.$$

Substituting this value of T in Eq (11)

$$W = \frac{2M\rho L}{RS_M}$$

When the bending moment is given and the length and density is constant:

$$W = \frac{Constant}{RS_M}$$

Thus, to obtain a design of minimum weight both the radius and the working stress should be as large as possible. However, increasing these two variables decreases the thickness and tends to make the elastic instability the limiting criterion.

The minimum obtainable thickness is also governed by the available production equipment and methods. The limitations due to this factor should be established before checking the cylinder for elastic instability.

2. The elastic instability is the limiting design criterion:

From Eq (10),

$$T = S'R/1.2 \times 10^7$$
$$= (Constant)\, S'R$$

Substituting for T in Eq. (11), the cylinder weight becomes:

$$W = 2\pi\, (Constant)\, S'R^2 L\rho$$

For a given length and constant material density,

$$W = (Constant)\, S'R^2$$

In this case, the critical buckling stress and the radius should be a minimum to keep the weight to a minimum. Decreasing these two factors causes the first condition of limiting working stress to become critical again. For design purposes a safe measure of excess of buckling stress over working stress must be chosen. An excess of 20 percent is considered sufficiently safe. For this condition

$$S' = 1.2S = 1.2 \times 10^7 \frac{T}{R}, \quad \text{or}$$

$$S = 10^7 \frac{T}{R}$$

From Eq (2),

$$T = \frac{M}{\pi R^2 S}$$

$$S = \frac{10^7 M}{\pi R^3 S}$$

$$S^3 = \left(\frac{10^7}{\pi}\right)\left(\frac{M}{R^3}\right) \qquad (12)$$

A graphical solution of Eq (12) is given in Fig. 8. For a given bending moment and a maximum allowable working stress, the one radius can be found which is required to give a cylinder of minimum weight, satisfying both stress requirements. From Fig. 6 the corresponding thickness can then be derived, the two dimensions giving the optimum cylinder design under the given conditions.

EXAMPLE:

A machined steel cylinder 40 in. long is to be subjected to a maximum bending moment of 5 x 10^5 lb-in. The cylinder is to pass through a casting of 5.25 in. maximum clearance. The allowable working stress under the given conditions is 70,000 lb/sq in.

The minimum wall thickness with available equipment is 0.09 in.

SOLUTION:

(*a*) From Fig. 8, for $S = 70{,}000$ psi and $M = 5 \times 10^5$,

This is larger than a permissible radius.

(*b*) Using a radius of 5 in.:
From Fig. 6, for $S = 70{,}000$ psi $M = 5 \times 10^5$ lb-in.

$T = 0.085$ lb. This is too small since the minimum thickness is given as 0.09 in.

(*c*) Using a thickness of $T = 0.09$ in.
From Lines I and II in Fig. 6, for
$S = 70{,}000$ lb/sq. in. and
$M = 5 \times 10^5$ lb-in.,

$R = 4.9$ in.

The optimum cylinder design requires $R = 4.9$ in. and $T = 0.09$ in.

The weight of the cylinder, using a steel density of 0.283 lb/cu. in., is 31.3 lb.

From Fig. 7 the critical buckling stress is found to be 170,000 lb/sq. in. which is more than required for safety.

III—LIMITATIONS AND ACCURACY

Elastic Stability in Torsion

The equation used for determining the critical buckling stress applies to cylinders for which

$$\frac{L}{R} < 6.6 \sqrt[4]{(1 - \epsilon^2)} \sqrt{\frac{R}{T}}$$

For steel, where $\epsilon = 0.3$, this limiting equation reduces to

$$\frac{L}{R} < 6.44 \sqrt{\frac{R}{T}}$$

Fig. 9 illustrates the above relationship. The derived equations and graphs for elastic instability in torsion apply to cylinders with values of L/R vs R/T lying in the area below the curve. Where L/R is larger than the given value, the equation no longer applies strictly and its use gives a higher buckling stress. As the cylinder becomes progressively thicker, the criterion of material failure becomes the predominant factor controlling the design. The combined graphs for torsion are susceptible to the errors inherent in the equation for shear stress (QR/I_p) which are considered later.

Simplifications were made in deriving the equation for buckling shear stress. For example, an extreme case that satisfies the limiting equation is: $R = 1.0$ in., $T = 0.3$ in. and $L = 10$ in. The error in stress when compared to precise calculations is 5 per cent acting in the sense of increased safety.

The equation for elastic instability in torsion theoretically applies to cylinders with hinged ends, Fig. 1, that is, the cylinder wall is free to change angle with cross-section but a circular section is maintained. This is an ideal condition and can only be approximated in practice. Using the formula and graphs for other end conditions gives a design of increased safety. In applying the equation to the extreme opposite ideal case of a cylinder with clamped ends and a circular cross-section, the error is 10 per cent acting toward increased safety.

Thus, the equation and graphs can be applied freely to general end conditions resulting in an error of 10 per cent maximum, on the safe side.

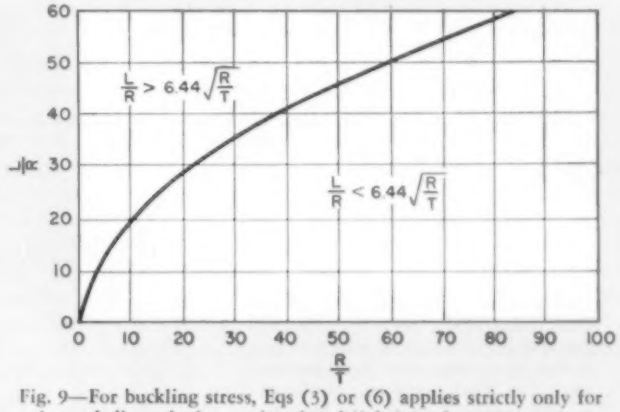


Fig. 9—For buckling stress, Eqs (3) or (6) applies strictly only for values of dimensionless ratios that fall below the curve.

Elastic Stability in Bending

For purposes of calculations involving bending, a cylinder is generally regarded as "thin" when the ratio of cylinder radius to wall thickness meets the following conditions:

$$\frac{R}{T} > \frac{15}{2}$$

The equation and graphs used hold strictly for this range. As the wall thickness is increased, failure from tension predominates and the errors caused by the use of the equation $S_M = MR/I_x$ apply.

There are no restrictions on end conditions, the cylinder being subjected to a certain bending moment at the cross-section under consideration as shown in Fig. 5(*A*), ideally or as would be experienced for example by the shell body of a guided missile in directed flight, Fig. 5(*B*), or the aircraft undercarriage in Fig. 4.

Material Failure due to Torsion or Bending

In deriving the stresses of torsion and bending, formulas involving TR/I_p and MR/I_x are used, respectively. The mean radius R is used both for the maximum distance from the cylinder axis and the derivation of the moments of inertia. To evaluate the moment of inertia, the equation $I_x = I_p/2 = \pi R^3 T$ is used instead of the more exact $(\pi/4)\ (R_o^4 - R_i^4)$

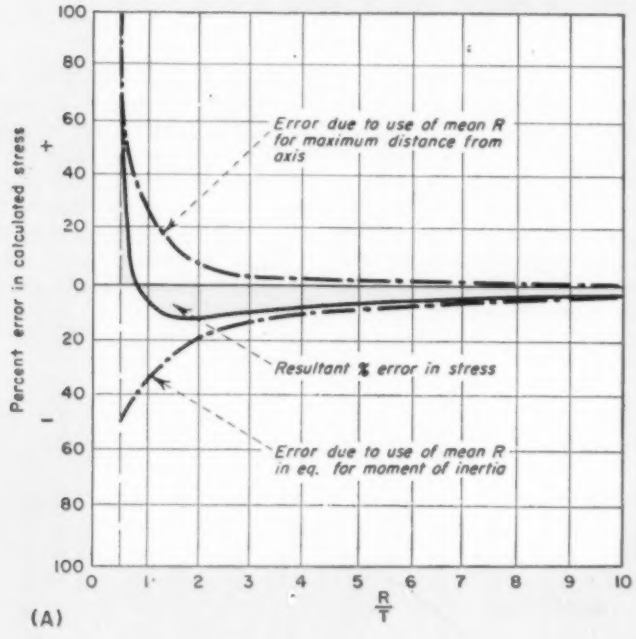
By using the mean radius instead of the outside cylinder radius for the maximum fiber distance from the axis, a stress smaller than the actual maximum stress is derived. The error in calculated stress depends upon the radius and thickness of the cylinder and is plotted in Fig. 10(*A*) as a negative error against the ratio R/T. In the extreme case of a solid round bar the error in stress is − 50 per cent. It becomes progressively smaller as the ratio becomes larger, reducing to − 4.7 per cent at $R/T = 10$.

The error in stress due to using a mean radius in the calculation of moment of inertia acts in the opposite sense, increasing the derived stress by an amount shown in Fig. 10(A) as a positive per cent error plotted against R/T. For a full circular section the eror would be 100 per cent. This, however, drops sharply giving a stress eror of 6.3 per cent for $R/T = 4$, and reducing to 0.1 per cent for $R/T = 10$. The solid curve in Fig. 10(A) represents the net stress error.

In Fig. 10(B) a correction factor for the above is plotted against R/T. If greater accuracies than those quoted are required, the stresses S_Q and S_M derived in the graphs are to be multiplied by the factor corresponding to the respective R/T. This will eliminate errors due to the use of the mean radius in the equations and give accurate corrected maximum stresses for cylinders of any thickness.

Both equations and graphs are generally applicable to hollow steel cylinders of any thickness and with general end conditions, bearing in mind that the accuracy of the results obtained is limited as described above.

The equations and graphs for material failure and those for elastic instability due to bending can be used with hollow cylinders irrespective of the material used in their construction. Those for elastic instability due to torsion are only applicable to steel cylinders. Graphs similar to those given can simply be derived for any other material used the respective modulus of elasticity E and Poisson's ratio in the basic equation.



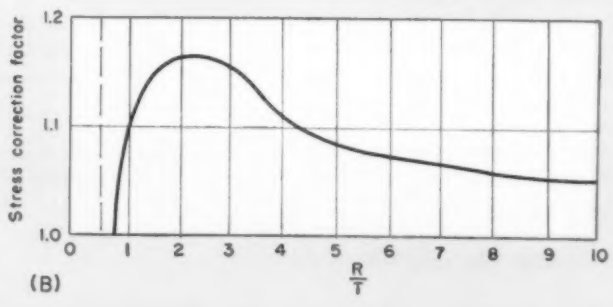


Fig. 10—Chart (A) shows how use of mean radius affects stress calculations. Curve in (B) is a correction factor that is applied to stress when these data are applied to "thick" cylinders. Deviation in stress is usually less than 10 per cent.

REFERENCES

1. Critical Buckling Shear Stresses in Thin Cylinders, J. J. Eden, *Product Engineering*, April 1953.
2. Formulas for Stress and Strain, Ch. 14, Art. 69, R. J. Roark, McGraw-Hill Book Co., Inc.

Versatile size and functional switch combinations can be produced from standard rolling-spring snap-action switch elements (springs, contacts, insulators, stack and gang mountings, etc.). Variables which can be manipulated in these switches are:

1. Assembly and mounting.
   a. Machine screws or eyelets (Single & multiple assemblies).
   b. Terminal location (Side or rear of switch).
   c. Multiple switch assembly combinations.
      (1) Stack(s) (Single or multiple).
      (2) Gang.
      (3) Combination of stacks and gang.
2. Switch sizes (Miniature, intermediate, or large, depending on available physical space and current-carrying requirements).
3. Type of actuator.
   a. Mechanical (Cam, roller, push-rod, toggle, etc.).
   b. Electrical (For remote and time-delay applications current through heating resistor flexes bimetal actuating arm built into switch).
   c. Thermal (Ambient temperature operates bimetal actuator).
4. Switch functions (SPST or SPDT in single basic switch unit).
   a. Return- or set-type operation in single switch. For SPST switch circuit can be:
      (1) Closed in non-operated and open in operated position.
      (2) Open in non-operated and closed in operated position.
   b. Multiple return-type switches (Stacked, ganged, or combination of two).
   c. Multiple set-type switches (Stacked, ganged, or combination).
   d. Multiple combinations of set- and return-type switches (Stacked and ganged).

Open-Blade Precision Snap-Action Switches

Functional combinations that can be obtained with standard open-blade snap-action switches and switch elements assembled to give single- or multiple-circuit control, spring return or positive actuation, simultaneous or sequential operation.

T. Y. KORSGREN
Chief Engineer
Acro-Mu Switch Div., Acro Mfg. Co.

OPEN-BLADE precision snap-action switches are similar to the enclosed types in movement differential, pretravel, overtravel, operating force, release force and other operating characteristics. The same precise manufacturing methods and premium materials, such as beryllium-copper spring members and silver contacts are used in the production of both types. The important difference between the two types is the skeleton aspect of the open.

This open-blade construction provides the designer with versatile switch building-blocks of varied application possibilities. A number of advantages of the open blade are: (1) Economy of design is possible because a relatively few number of stock detail parts can be assembled into a variety of switch types. (2) Actuation can be performed by thermal or electrical means as an integral part of the assembly. (3) More current can be handled than in comparable enclosed types since radiation is better. (4) For multiple circuit control from a single actuator, functional switch units may be stacked vertically, ganged horizontally, or stacked and ganged in the same assembly. (5) Sequential operation of multiple circuits may be obtained from a single actuator in single or multiple stacks. (6) Combinations of two or three types of switch functions can be assembled in one unit—for example, return, set, and sequentially-operated types may be combined with fail-safe arrangements for operation by a single actuator. (7) Economy and space saving are possible by design of a combined housing for both switch and operating components. (8) Open-blade switch assemblies offer several

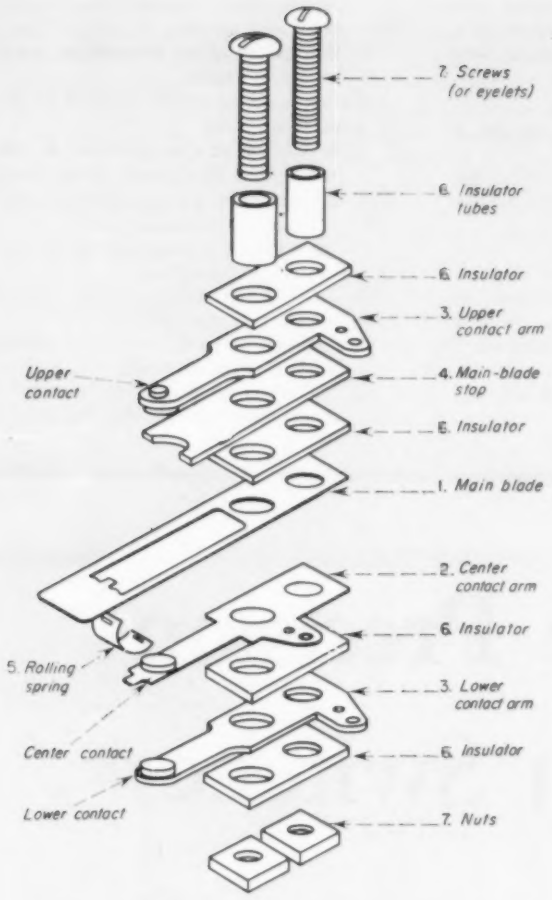


Fig. 1—Single-pole, double-throw, open-blade, snap-action switch, showing assembly details. Varied switch sizes and functions are obtained by proper choice of switch elements. Machine screws and nuts (7.) which are used to fasten the assembly together are also used for mounting.

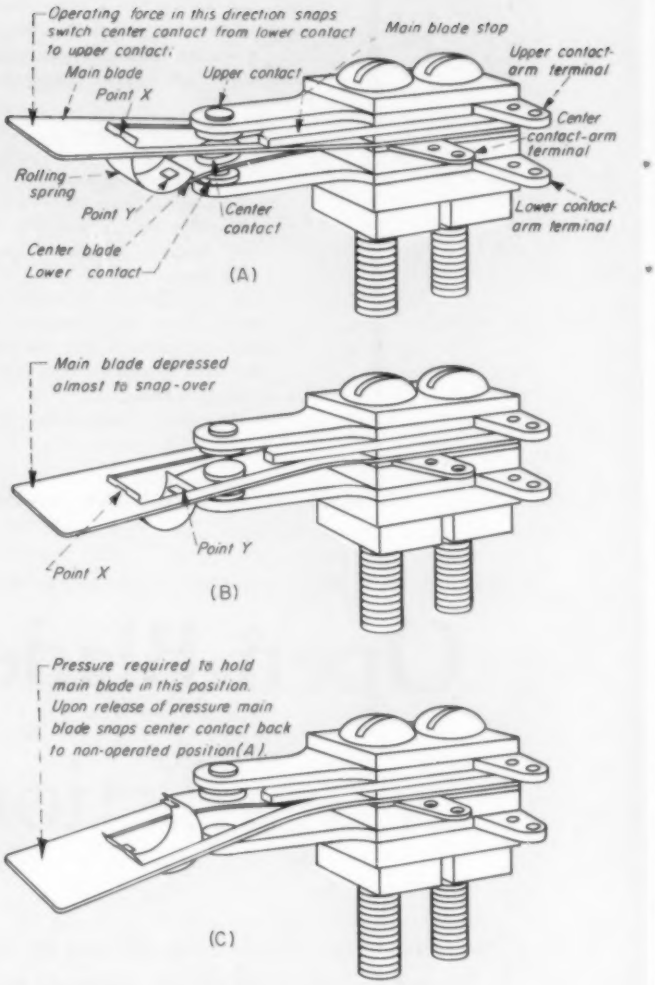

Operating force in this direction snaps switch center contact from lower contact to upper contact.
Main blade stop
Upper contact-arm terminal
Main blade
Point X
Upper contact
Center contact-arm terminal
Rolling spring
Point Y
Center contact
Lower contact-arm terminal
Center blade
Lower contact
(A)
Main blade depressed almost to snap-over
Point Y
Point X
(B)
Pressure required to hold main blade in this position. Upon release of pressure main blade snaps center contact back to non-operated position (A).
(C)

Fig. 2—Open-blade snap-action switch with return-type operation. (A) Switch in non-operated position. (B) Switch main blade depressed close to snap-over point. (C) Switch main blade depressed to operated position.

good functional mounting possibilities.

The prime limitation of the open-blade switch is its lack of enclosure. It must be integrated into the design of some other component or product. Devices into which the open-blade switches are built include: thermostats; motion-limit controls; fan controls; domestic-heating controls; pneumatic or liquid pressure controls; thermal, electrical and mechanical relays; start-winding switches in split-phase motors; electric fuel pumps; watt hour meters; and in timing and sequential-functioning operating devices.

FUNCTIONAL CONSTRUCTION

Fig. 1 is an exploded view of a rolling spring single-pole double-throw (SPDT) snap-action switch showing assembly details. The switch consists of: *1* a main blade or actuating leaf; *2* a flexible center contact arm; *3* upper and lower stationary contact arms; *4* a main-blade stop against which the blade rests in the non-operated position; *5* a highly-stressed member called the rolling spring; *6* the necessary number and types of insulation members; and *7* machine screws and nuts which fasten the assembly together and which are also used for mounting. Eyelets, instead of screws, may be used for assembly fastening purposes.

The same switch is shown assembled in Fig. 2(A) in the non-operated position. The rolling spring and main blade are the principal members in which energy is stored. The main blade acts as a supporting and reaction member for the rolling spring, and since

Table I—Data on Standard Types of Open-Blade Snap-Action Switches

Fig 3 Ref	Current Rating (amps) at 125 vac	Switch Type*		Contact Gap (in.)	Operating Force (oz max)	Release Force (oz min)	Overtravel (in. min)	Movement Differential (in.max)	Overall Dimensions (in.)		
		SPST	SPDT						L	W	H
(A)	12	..	R	0.010–0.015	2–5	1.5	.....	0.020	7/8	1/4	9/16
(B)	3	R	R	0.010	3–6	2	.....	0.062	1–13/32	5/16	1/64
		R	R	0.020	6–10	2	.....	0.062			
		S	S	0.020	3–5	2	.....	.....			
(C)	15	...	R	0.020–0.030	3–6	1.5	0.063	0.063	2–1/32	3/8	15/32
(D)	15	R	R	0.020	3–6	1.5	0.063	0.063	2–1/32**	3/8	13/32
		R	R		2	0.5	0.063	0.063			
		S	S		1–2	1–2	0.063	0.063			
(E)	15	R	R	0.040–0.060	4–6	2	0.063	.....	2–15/16**	11/16	15/32
		S	S	.....	2–4	2–4	0.063				
	25	R	R	.....	4–6	2	0.063				
		S	S	.....	2–4	2–4	0.063				

* R indicates return-type action; S indicates set-type action
** Does not include length of phenolic insulator.

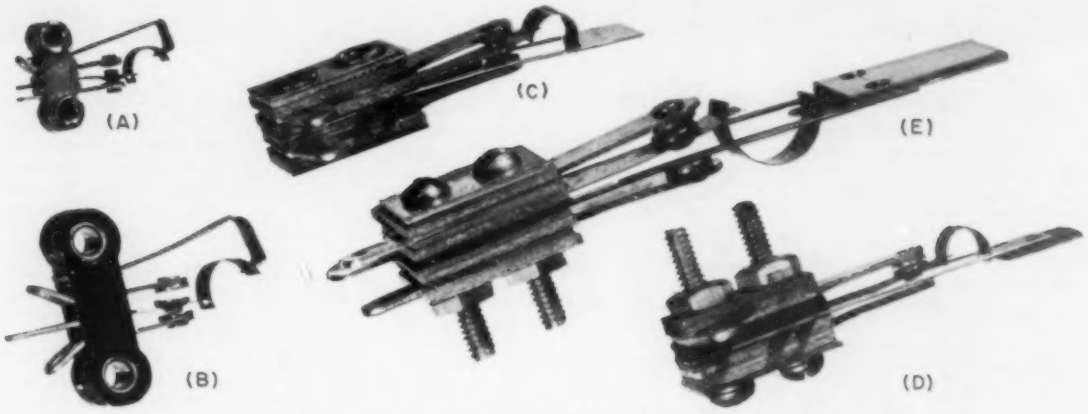


Fig. —Open-blade precision snap-action switches. Dimensions and other data appear in Table I. Figs. 1(E) and (D) show actuating blade with phenolic insulator attached.

this blade has a spring "bias" the switch is a return type. Actuating force in the downward direction, as shown in (A) and (B), flexes the main blade and rolling spring. As the main blade is depressed, point *X* approaches the same plane in which point *Y* lies. In (B) the main blade is depressed to the point just before snap-over action takes place. When point *X* passes *Y*, toggle action occurs as shown in (C). This action is a true rolling motion which results in smooth, rapid actuation.

In the type of snap-action switch which uses a single prestressed blade, a spring force tends to keep the contacts closed and an actuating force opposes the spring force. As the actuating force overcomes the spring force, contact pressures decrease. If contact pressures are allowed to remain at reduced values for any length of time, such as during very slow actuating movements, the current-carrying capacity of the switch decreases as contact pressure approaches zero. In the rolling-spring snap-action switch contact pressure increases during actuation up to the point of snap over. The flexible center contact arm then breaks away with rapid acceleration, seating the contacts in the new position with a minimum of bounce.

In the prestressed type of switch, the spring member carries the entire electrical load. In the rolling-spring type of switch the rolling spring and main blade are independent of current-carrying duties and are therefore not influenced by the load current.

Fig. 3 shows several sizes and shapes of standard single-pole open-blade switches. The larger types in (C), (D), and (E) are assembled as pre-

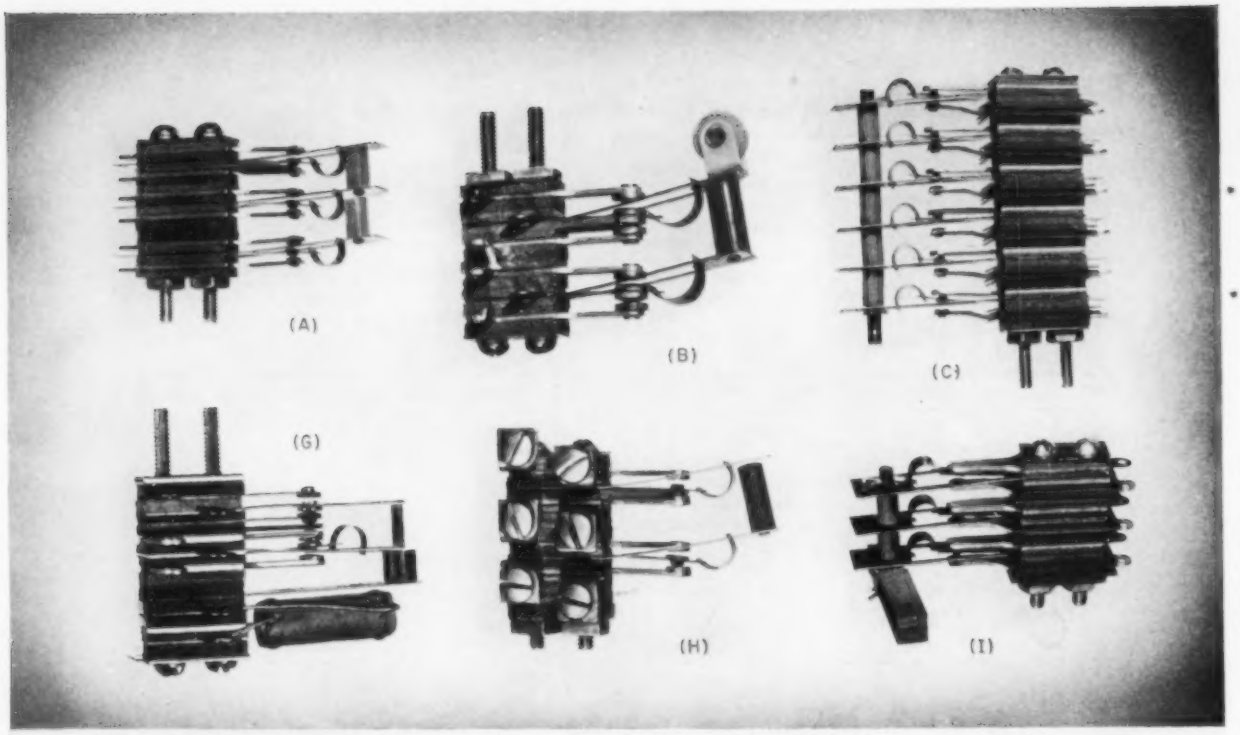


Fig. 4—Stacked open-blade snap-action switches. Simultaneous, sequential, or combined simultaneous-sequential control of multiple switches are obtained in various stacking arrangements. (A) Three-stack DPDT assembly, return-type action; nylon actuators are used between main blades. (B) Two-stack DPDT with heavy-duty blades and contacts; return-type action with nylon roller and phenolic actuator added. (C) Six-stack DPDT assembly with return-type action. (D) Miniature fabricated two-stack DPDT assembly with nylon actuator—a 3 amp

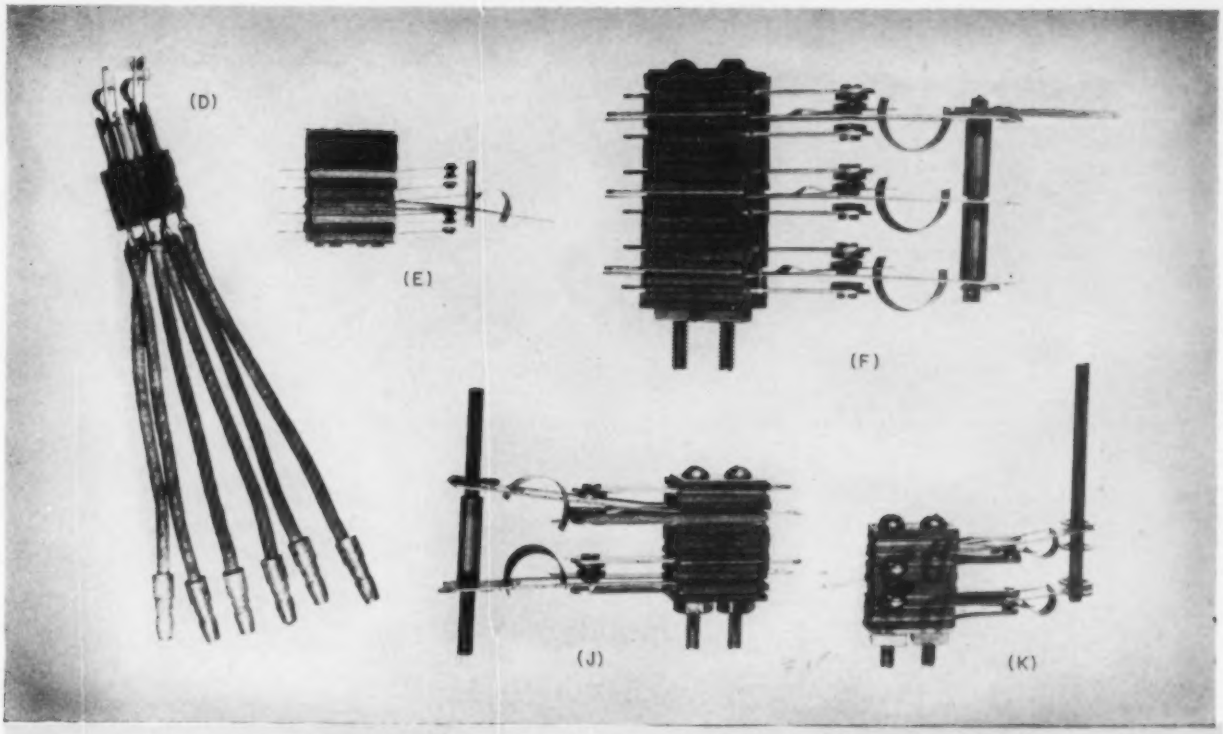
Table II—Maximum Current Loads for Intermediate Size Open-Blade Switch

Contact Gap	Nominal Volts	Non-Inductive Load				Inductive Load Room Pressure	
		Heater		Lamp			
		*Non-Op Amps	*Op Amps	*Non-Op Amps	*Op Amps	*Non-Op Amps	*Op Amps
60 Cycle Alternating Current, 50 Actuations Per Minute							
0.010 thru 0.070	6	20	20	10	20	20	20
	12	20	20	8	10	20	20
	24	15	18	4	6	15	20
	125	15	15	1.5	3	15	15
	250	15	15	1.25	2.5	15	15
Direct Current, 25 Actuations Per Minute							
0.010	6	15	20	1.5	3	8	8
	12	15	20	1.5	3	5	5
	24	2	2	1.5	2	1	1
	110	0.4	0.4	0.4	0.4	0.03	0.03
	220	0.2	0.2	0.2	0.2	0.02	0.02
0.020	6	15	20	1.5	3	15	20
	12	15	20	1.5	3	10	10
	24	6	6	1.5	3	5	5
	110	0.4	0.4	0.4	0.4	0.05	0.05
	220	0.2	0.2	0.2	0.2	0.03	0.03
0.040	6	15	20	1.5	3	15	20
	12	15	20	1.5	3	15	20
	24	10	10	1.5	3	10	10
	110	0.6	0.6	0.6	0.6	0.1	0.1
	220	0.3	0.3	0.3	0.3	0.05	0.05
0.070	6	15	20	1.5	3	15	20
	12	15	20	1.5	3	15	20
	24	15	20	1.5	3	10	10
	110	0.75	0.75	0.75	0.75	0.4	0.4
	220	0.3	0.3	0.3	0.3	0.2	0.2

* "Non Op" indicates switch is in non-operated position.
* "Op" indicates switch is in operated position.

viously shown in Fig. 1. The midget open-blade switch elements in Fig. 3(A) are captured by molded nylon pieces fastened together with eyelets; (B) shows use of molded bakelite for the same purpose. Table I lists pertinent data for the switches shown in Fig. 3(A), (B), (C), (D), and (E). These and other standard single-pole switches are the basic building-blocks from which the multi-pole and multi-function switches shown in Figs. 4, 5, and 6 are constructed.

Approximate maximum load currents for the intermediate-size open-blades shown in Fig. 3(C) and (D)



switch which has six No. 18 leads soldered to the terminals, permitting ready installation, removal, or replacement. (E) Basic variation in this stacked switch is the arrangement using a single rolling spring to move switch center arms rather than two individual rolling springs. Number of elements which can be controlled in this fashion is limited. (F) Three-stacked DPDT assembly, return action similar to (A) but of heavy-duty construction, with a flat phenolic insulator riveted to the top main blade for actuation purposes. (G) Electrical actuation of two-stack DPDT is produced by current flow through heater-resistor located under bimetal actuating member. Five to 25 watts are required for this type actuation, with time delay from a minimum of 15 sec. Lower switch is snap-action while upper is not. (H) Two-stack DPDT assembly with screw terminals. (I) Three-stack DPDT assembly stacked so that the switches operate in sequence of 1-2-3, with special actuator included which permits the switch to be actuated 1 in. off to one side. In this case a three-stack arrangement is required to provide sufficient lateral stability for offset actuator to work properly. (J) Two-stack DPDT assembly combining one set-type and one return-type switch. Three functions are: Pressing actuator downward snaps both center contact arms up against top contacts; releasing pressure on actuator causes upper switch center arm to snap back down, while lower switch center arm remains against upper contact; pressing actuator upwards snaps lower switch center arm back against lower contact. (K) Two-stack DPDT assembly. Actuation up or down snaps upper first.

are listed in Table II. The maximum allowable current for a given a-c voltage depends upon the size gap, type of load such as inductive, heater, or lamp load, and number of actuations per minute. Direct current may be used with these switches, but this imposes current limitations listed. The tabulation is only a general guide, and is not all-inclusive. It is based on tests and values used by Underwriter's Laboratories to establish listings and U/L ratings for small snap-action and special-use switches.

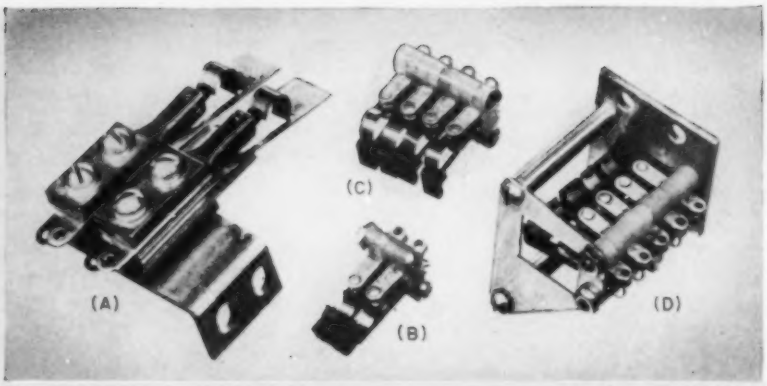
A minimum of 500,000 operations can be expected of standard open-blade switches. By limiting: (1) the number of actuations per minute, (2) the pretravel, and (3) particularly the overtravel, switch life may be extended to several million operations. In special applications hundreds of millions of actuations have been obtained.

These switches can be operated in ambient temperatures of from —20 to 250 F. Operation in excessively high ambient temperatures or at excessive actuating speeds over extended periods of time does not allow the switch blades to adequately dissipate heat generated at the contacts. Under these circumstances the contacts degenerate.

COMBINING FUNCTIONS

Stack assembly of open-blade switch elements produces interesting multi-circuit and multi-function combinations, some of which are shown in Fig. 4. Simultaneous, sequential, or a combination of simultaneous-and-sequential control of multiple circuits can be effected by a single actuating motion of the stack elements. Return-type, set-type, or a combination of both actions can be included in any one of the assemblies shown above in Fig. 4.

Fig. 5—Ganged switch assemblies for multiple-circuit control. Simultaneous or sequential operation can be obtained by proper design of actuating cam. (A) Intermediate open-blade switch in a two-gang assembly. (B), (C) and (D) Two, four, and five-gang assemblies of midget open-blade switches showing possibilities of multiple circuit control with minimum space requirements. These switches are rated at 12 amp, 125 volts ac.



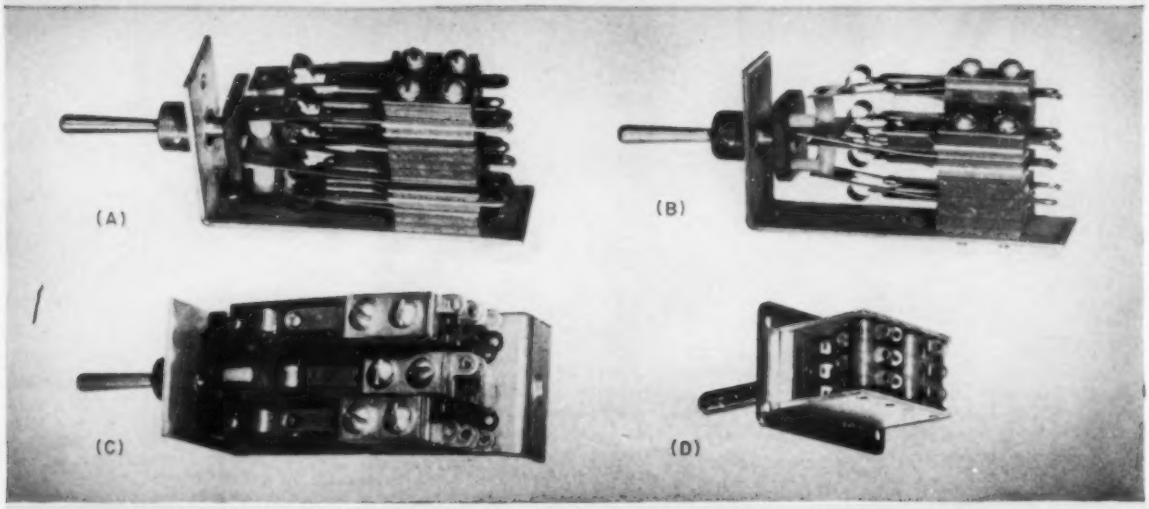


Fig. 6—Combinations of stacked and ganged open-blade switches, including return and set-type functions. Toggle actuators are shown, but switches can be readily used with other type actuators.

(A) Two-gang, four-stack SPST assembly with return-type action. Control of eight independent circuits is possible with this switch. Upper four switches operate as one group, lower four operate as second group. In center-neutral position of toggle one circuit in each group is closed, three others open. Depressing toggle operates upper four switches, opening closed circuit, and closing three open circuits. Elevating toggle operates lower group of four in similar manner. Upon release, toggle automatically returns to neutral.

(B) Two-gang multiple-stacked assembly with combined return- and set-type actions. Larger stack is four-pole single-throw with return-type action. Smaller stack is SPDT with set-type action. This combination provides a "memory" to switch, since once switch has been actuated in a given direction, the set-type switch remains operated in that direction, upon release of the toggle. Further operation of the toggle in same direction will not operate set-type main blade. This feature can be used to control fail-safe circuits.

(C) Three-gang, multiple-stacked assembly, similar to (B), but with a second return-type four-stack SPST assembly added, increasing flexibility of combination. Set-type switch is retained.

(D) Two three-gang midget assemblies stacked two high giving six SPDT switches with return-type action in pace 1¼ in. high, ¾ in. wide, by 1 in deep.

Gang assembly of switch units along a horizontal axis offers a second basic multiple-switch arrangement. Fig. 5 shows some of the possibilities, with emphasis on the use of midget open-blade switches. Sequential operation is possible with ganged switches by proper design of an actuating cam. The combination of return and/or set-type action is dependent on the particular application in which it is used.

Combinations of stacked-and-ganged switches (with return and set-type functions) are shown in Fig. 6. These examples show toggle actuators, however, such combinations can readily be adapted to other types of mechanical actuation, such as cams, push-rods, etc. Fail-safe arrangements or a "memory" are incorporated in switches shown in Figs. 6(B) and (C) by including a set-type switch in the assembly. Once the toggle has been actuated in a given direction, the set-type switch remains in that position and may be used to: (1) light an indicator lamp showing the last direction in which switch was

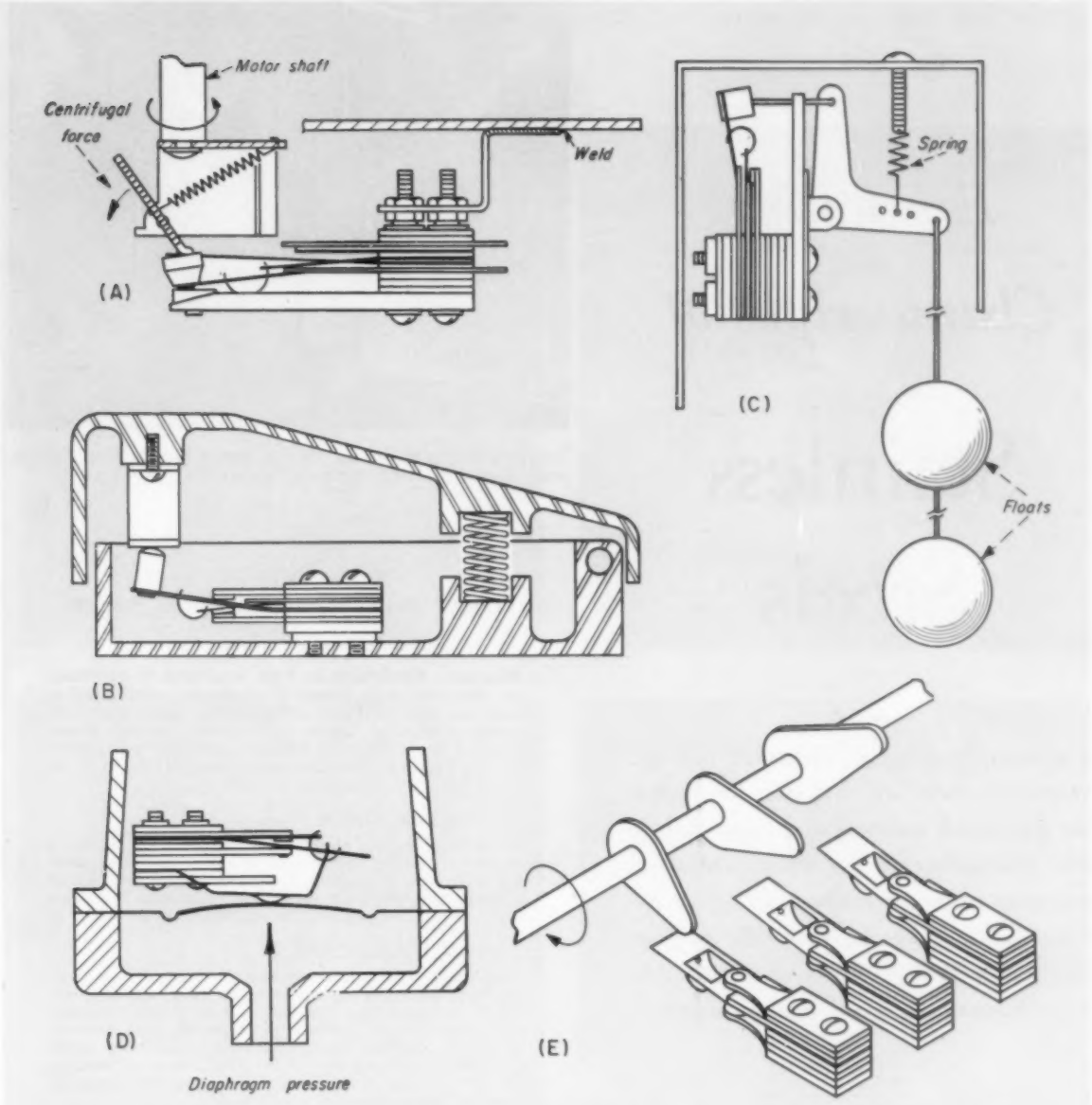


Fig. 7—Typical applications of open-blade switches. (A) Motor starting switch, operated by centrifugal force, is used to cut out starting winding on split-phase motor. (B) Foot switch for business machines. (C) Float-operated sump-pump switch which starts pump motor when liquid level reaches high point and cuts off motor when pump has reduced level. (D) Switch operated by pressure on diaphragm. This may be used for liquid or gas control. (E) Sequence timer switches. They can be multiple types, operating several circuits simultaneously.

operated, or (2) to control fail-safe circuits. Six single-pole double-throw switches shown in Fig. 6(D) occupy a space 1.25 in. high, 0.75 in. wide, by 1 in. deep.

Typical applications of standard open-blade switches are shown in Fig. 7. These applications include: (A) Split-phase induction motor starting switch. When motor is still, spring holds actuator against main blade in operated position, cutting starting winding into power circuit. When motor reaches a predetermined speed, centrifugal force pushes actuator at right angles to shaft, removing pressure from main blade; main blade snaps up, removing starting winding from circuit. (B) Foot switch for business machines. (C) Float-operated sump-pump switch. (D) Diaphragm-pressure operated switch. (E) Multiple cam-operated sequence timer. Switches can be stacked, operating many circuits simultaneously from one cam. Cams are insulated and sequence is determined by relative cam positions.

Fabricating Characteristics of

Stainless Steels

Fig. 1—Grinding of circular weld on end of large tank typifies the many methods of fabricating stainless steel.

In addition to corrosion resistance, cost and availability, there are vital selection factors that distinguish stainless steels according to their adaptability to the many fabricating processes—cutting, working, joining, or finishing. Article relates the many different processes to the three basic types of stainless steels—martensitic, ferritic and austenitic.

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Stainless Steel Specialist
American Iron and Steel Institute

Principal Characteristics of Three Basic Types of Stainless Steels*

CHROMIUM—TYPE I

Magnetic; hardenable by heat treatment to martensitic structure; high degree of toughness; readily hot or cold worked; machines satisfactorily (free machining grades available); can be cold riveted, but not generally hot riveted; can be welded (control of air hardening necessary); corrosion resistance satisfactory for most uses; scale resistant to 1,200 F.

CHROMIUM—TYPE II

Magnetic; ferritic; slightly hardenable; may be notch sensitive; readily hot or cold worked; machines satisfactorily (free machining grade available); can be cold riveted and welded; corrosion resistance increases with chromium content; scale resistant to 2,000 F.

CHROMIUM—NICKEL

Non-magnetic as annealed; slightly magnetic as cold-worked; austenitic; hardenable by cold working, not by H. T.; very high toughness, even at low temperatures; readily hot worked; most readily cold worked; poor for complex machining (free machining grade available); can be cold or hot riveted; best for welding by all methods; best corrosion resistance for equal Cr content; scale resistant to 2,100 F.

**This compilation must, of necessity, be general because of the wide range of properties available in the thirty-odd standard stainless steels.*

ANY METAL has special rules for fabrication, and stainless steels are no exception. Their fabrication is different, but not difficult. By reason of their high strengths, stainless steels require greater power in working operations than do most ferrous materials. Modifications, therefore, become necessary to handle springback and avoid ironing. Yet, in many cases, because of the greater strength of stainless, thinner stock can be used.

In machining operations, the toughness and strength of stainless causes a certain amount of "gumminess." Free-machining grades have been developed with machinability from 85 to 90 per cent of Bessemer screw stock. And, for weldability, the austenitic (chromium-nickel) types are unexcelled. Welded joints are strong, tough, and ductile.

Each of the 31 types of stainless to be described has advantages and limitations for given fabrication processes. The superiority of one type for a particular operation is a matter of degree. Table I classifies individual grades by degree of suitability for particular methods of fabricating.

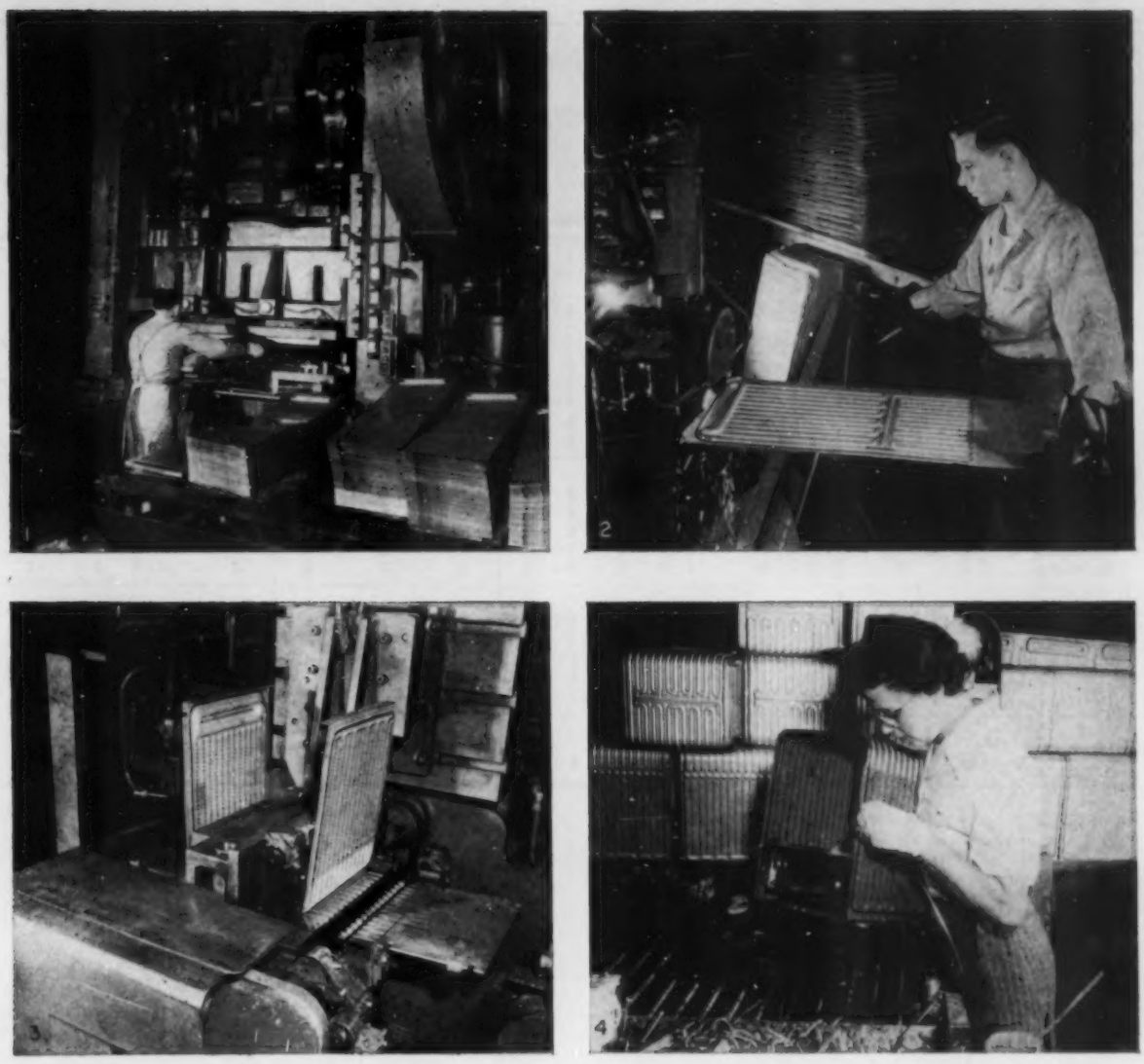


Fig. 2—Fabrication of stainless steel refrigerator evaporator shell requires several different metal working operations . . . (1) drawing to form corrugations; piercing and trimming in a large press . . . (2) intermittent seam welding of two drawn sheets to form gas-tight channels . . . (3) forming of double-walled assembly on tangent bender . . . and (4) silver soldering of copper tubes into swaged holes.

TYPES OF AISI STAINLESS STEELS

Martensitic Types (403, 410, 414, 416, 420, 431, 440A, 440B, 440C). The steels in this group are hardenable, since they have a high enough carbon-to-chromium ratio so that they will undergo the necessary transformations. Their best mechanical as well as corrosion-resisting properties are found in the hardened condition. Tensile strengths range from 70,000 to 105,000 psi when annealed; 125,000 to 200,000 psi when hardened.

Thermal conductivity of the martensitic group is low, but still the best of the stainless family. They are especially suitable for hot working or forging; are air-hardening, and must be slowly cooled (or annealed) after forging to prevent cracking. Their cold-forming characteristics are fair.

The martensitic types are well suited for most moderately corrosive applications requiring high strength, hardness, and resistance to abrasion and wet and dry erosion.

Ferritic Types (405, 430, 430F,

Table I—Workability of Annealed Martensitic, Ferritic and Austenitic Stainless

The following charts present relative workability ratings for the different types of stainless steels in the austenitic, martensitic and ferritic groups. No attempt has been made to correlate among groups. In the case of the martensitic

Code: 1. Exceptionally good; 2. Well suited (norm); 3. Precautions necessary

	AUSTENITIC TYPES — Work Hardenable													
	18–8							Higher Cr-Ni			18–8 Stabilized		18–8 with Molybdenum	
	301	302	302B	303	304	304L	305	308	309, 309S 310, 310S	314	321	347	316 317	316L
1. Cutting														
A. Shearing (Blanking, perforating, notching, slitting, expanding, punching)	2	2	2	2	2	2	2	2	2	2	2	2	2	2
B. Machining[c]														
Turning & milling	2	2	2	1	2	2	3[b]	3[b]	3[b]	3[b]	2	2	3[b]	3[b]
Drilling, tapping & reaming	2	2	2	1	2	2	2	2	2	2	2	2	2	2
Boring	2	2	2	1	2	2	3[b]	3[b]	3[b]	3[b]	2	2	3[b]	3[b]
Planing	2	2	2	1	2	2	3[b]	3[b]	3[b]	3[b]	2	2	2	2
Broaching	2	2	2	1	2	2	2	3[b]	3[b]	3[b]	2	2	3[b]	3[b]
2. Working														
Forging	2	2	2	3[d]	2	2	2	2	3[e]	3[e]	2	2	3[e]	3[e]
Bending & roll forming	2	2	2	3[g]	2	2	2	2	2	2	2	2	2	2
Drawing	3[h]	2	..	3[g]	2	2	1	3[i]	3[i]	3[i]	2	2	2	2
Stamping & Hydroforming	3[h]	2	..	3[g]	2	2	2	2	2	2	2	2	2	2
Spinning	3[h]	2	..	3[g]	2	2	1	2	2	2	2	2	2	2
3. Joining														
Fusion welding	2	2	3[j]	4	2	1[k]	2	2	2	3[j]	1[k]	1[k]	2	1[k]
Resistance welding	2	2	3[j]	4	2	2	2	2	2	3[j]	2	2	2	2
Brazing & high-temp soldering	2	2	2	4	2	1[k]	2	2	2	2	1[k]	1[k]	2	1[k]
Soldering	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Riveting	3[h]	2	..	4	2	2	1	..	..	..	2	2	2	2
4. Finishing														
Polishing & plating	2	2	2	3[m]	2	2	2	2	2	2	3[m]	2	2	2

a. Slightly greater care required because of high chromium content.
b. Because of the "gumminess" of these austenitic steels, slower speeds and low feeds are necessary.
c. Reference figures for comparative machinability (based on cold-finished stock):

Bessemer Screw Stock.....100
416.....85
430F.....90
303.....75
302.....45
430.....54

d. Free-machining steels are somewhat susceptible to hot shortness. Temperatures must be controlled within close limits.
e. Because of elevated temperature strength, these steels require higher pressures and special die considerations.
f. More power and smaller cuts are necessary because of greater hardness of annealed steel.

446). These alloys are not hardenable, since they have a lower carbon-to-chromium ratio which reduces the effect of the transformation responsible for hardening. But while they cannot be hardened by heat treating, hardness can be increased slightly by cold working. In practice, however, these steels are rarely used in the cold worked condition.

The ferritics have a lower coefficient of expansion than the austenitic types of stainless—about the same or slightly less than that of carbon steel. They exhibit good resistance to corrosion.

While their ductility is less than that of the chromium-nickel types, they can be fabricated without difficulty by such methods as forming, bending, spinning, and shallow drawing. And they can be buffed to a high finish. Welding is possible. Occasional brittleness can usually be overcome with proper heat treatment. Type 430T, containing titanium, has excellent welding characteristics.

The ferritic grades have higher resistance to corrosion and oxidation than the martensitic types. Like the martensitic types, they are magnetic.

Austenitic Types (301, 302, 302B, 303, 304, 304L, 305, 308, 309, 310, 310S, 314, 321, 347, 316, 316L, 317). Steels in this group possess the highest corrosion resistance of the stainless steels. The austenitics are inherently tough and well-adapted for fabrication by deep drawing and other similar processes. They are readily weldable and can be soldered by proper technique. Type 303, contains additives which improve machinability.

The austenitic stainless steels are not hardenable by heat treatment and are non-magnetic; their ductility is unusually high. Tensile strength in the annealed condition is considerably above that of mild steel—about 90,000

Steels Relative to Various Methods of Fabrication

steels. Type 410 is considered the norm and variations are indicated as deviating from it. Similarly, in the ferritic steels, Type 430 is the norm, and in the austenitic types, 302 is the norm.

4. Inadvisable, try another material

	FERRITIC TYPES — Non-Hardenable					MARTENSITIC TYPES — Hardenable By Heat Treating			
	405	430	430F	431	446	403 410 414	416	420	440A 440B 440C
1. Cutting									
A. Shearing (Blanking)	2	2	2	2	2	2	2	2	2
Perforating, notching, slitting, expanding, punching	2	2	2	2	4[a]	2	2	2	2
B. Machining[g]									
Turning, milling, boring, reaming, planing, broaching	2	2	1	2	2	2	1	3[f]	3[f]
Drilling and tapping	2	2	1	2	2	2	1	2	3[f]
2. Working									
Forging	2	2	3[d]	2	2	2	3[d]	2	2
Bending, roll forming, drawing, stamping & Hydroforming	2	2	3[e]	2	2	2	3[e]	2	2
Spinning	2	1	3[e]	2	4[a]	2	3[e]	2	..
3. Joining									
Fusion welding	1	2	4	2	4[a]	3[l]	4	3[l]	3[l]
Resistance welding, brazing, high-temp soldering	2	2	4	2	4[a]	2	4	2	2
Soldering	2	2	2	2	2	2	2	2	2
Riveting	1	1	4	2	..	1	4	..	..
4. Finishing									
Polishing & plating	2	2	3[m]	2	2	2	3[m]	2	2

g. Additions to improve machining characteristics lessen formability.
h. Higher work hardening characteristics of this grade make it less suitable for any but the more shallow draws.
i. Somewhat more difficult to draw than the basic type; generally drawn only when ultimate use necessitates these alloys.
j. Higher silicon content may necessitate special care to avoid cracking.
k. These steels show freedom from harmful carbide precipitation caused by welding heat. They are not necessarily easier to weld so far as the mechanical operations of welding are concerned.
l. Can be welded, but pre-heating, post-heating, or both, are usually required to prevent cracking.
m. Discontinuities in high polishes and finishes.
n. Formability restricted because of greater hardness of annealed steel.

psi as compared with 50,000 psi. Austenitic stainless has a yield point of approximately 35,000 psi which is comparable with that of mild steel.

These steels can be work hardened to extremely high tensile and yield strengths and still maintain good ductility. Tensile strengths up to about 200,000 psi can be developed in flat rolled products, and in excess of 300,000 psi in fine drawn wire. Because of this work-hardening characteristic, it is sometimes necessary to re-anneal the material between operations in fabricating processes such as drawing or spinning.

FABRICATING THE STAINLESS STEELS

Cutting. Since stainless is stronger and tougher than ordinary carbon steels, heavier tools and more rigid equipment are desirable for any cutting operation. From 30 to 50 per cent greater shear capacity is usually required. The martensitic and ferritic stainless steels present no special problems; however, the austenitic types require especially close adjustment of shear blades. With the latter materials, it is necessary to cut further through the thickness of metal, since pieces will not snap off when partially cut through as soon as will other metals.

For *blanking* and *punching*, the higher toughness and strength of stainless requires more power and slower speeds. The austenitic stainless steels are somewhat more difficult to blank and punch than the other grades. Small clearances should be maintained to keep the metal from being drawn into the die. A general rule is to work to a clearance of 1/10 the thickness of the metal being blanked or punched.

In *perforating*, from 75 to 100 per cent more force will be required than

for mild steel. Again, care should be taken in setting clearances for all three types of stainless, the austenitic types requiring especially close clearances. Holes should not be smaller in diameter than the thickness of the material. Recommended minimum diameter is 1½ to 2 times the thickness of the material.

Machining. Ferritic stainless steels are easiest to machine; the annealed martensitic types are somewhat more difficult; and the austenitic types, because of their work hardening properties, are the most difficult. Special care should be taken with the austenitics to avoid work hardening the surface.

Stainless Types 430F and 416 have been developed especially for machining purposes. Type 430F can be machined at rates approximately 80 to 90 per cent of Bessemer screw stock; Type 416, approximately 75 to 80 per cent of the Bessemer standard. If a non-machining grade is selected for higher mechanical or corrosion-resistant properties needed in the finished product, some sacrifice in machining properties will result.

Forging. Stainless steels can be forged without difficulty when proper precautions are observed. With the materials' low heat conductivity and high strength at elevated temperatures, heating should be slowly. An average of 25 per cent more blows under the hammer are required than for plain carbon steels. Forging die life in stainless steel operations is about 25 per cent less than for mild steels.

Forging temperatures vary for the different stainless steels. Data available from the individual stainless steel producers and distributors should be consulted for specific types.

Bending and Roll Forming. Stainless is often bent or formed in conventional bending brakes. Where production warrants, continuous lengths can be formed in elaborate cross sections using a progressive series of shaped forming rollers.

Bending and roll forming operations are most commonly done with the austenitic and ferritic stainless steels, because they are ideally suited for these methods of cold working. These grades require approximately twice the tool capacity needed for mild steel in these operations. The martensitics are not usually formed with these techniques.

By proper design of the forming rolls, extremely sharp corners with small radii are possible. Steady, continuous forming, as in roll forming, is preferable to abrupt, step-by-step forming, as on brakes, if complex contours are being developed. This is particularly applicable to the austenitic grades.

Deep Drawing. All stainless steels require considerably more power and heavier equipment for deep drawing than do plain carbon steels of the same thickness. The austenitic stainless steels are well suited for drawing operations. They have a ductility even greater than that of deep drawing carbon steel. It should be noted, however, that these chromium-nickel types work harden rapidly. Slower press needs are necessary for maximum depth draws, and to achieve uniform work hardening and elongation.

The ferritic and martensitic stainless steels are less ductile than the austenitics. The ferritics can be satisfactorily deep drawn although less severe reductions per step are possible. The martensitics, except Type 410, are drawn infrequently, and with less severe draws.

Spinning. By its very nature, spinning is a severe cold working operation. With lower work hardening characteristics, the ferritic grades are well suited for these operations. Spinning will work harden the austenitic stainless steels faster than other forming operations, frequently requiring that the work be re-annealed more often than if the object were formed by drawing. Type 305 is a special spinning grade which work hardens much more slowly than Types 302 or 304. More frequent process annealing is required with the other 300 series stainless steels and with the 400 series martensitic grades. The martensitic grades are rarely spun.

JOINING STAINLESS STEELS

Riveting. The chromium-nickel stainless steels can be riveted cold when the rivet diameter is less than $\frac{3}{16}$ inch. To reduce the effect of hardening under cold work, it is desirable to set rivets in one blow rather than in a rapid succession of blows. Button heads are for cold work.

On larger sizes, the operation is best performed hot. Riveting should be finished above 1,600 F to avoid driving within the range of lower ductility. To insure this, driving should take place when the temperature is between 1,900 and 2,050 F.

The straight chromium stainless steels, except Types 420, 440, 442 and 446, can be driven cold in smaller diameters. Larger diameters should be hot riveted. With martensitic types, heating should not exceed 1,450 F, otherwise air hardening may cause the heads to snap off during cooling.

Maximum temperature used in hot riveting the ferritic types must be carefully controlled to avoid increasing grain size and consequent loss of ductility. Type 430 should not be heated above 1,500 F; Types 442 and 446 not in excess of 1,600-1,700 F.

Rivet holes can be drilled or punched, with drilling recommended to prevent excessive stress. Punching should be followed by reaming.

Soldering. All types of stainless are solderable, either with the soft lead-tin or the hard silver solders. This joining method is recommended only as a means of filling or sealing joints, and should not be depended upon for mechanical strength. Joints to be sealed by solder should always be spot welded, riveted, or joined by other mechanical means if strength is required. Welding is preferable.

Brazing. Since stainless steels can readily be welded by any of a number of processes, brazing is not recommended as a joining technique. While it is possible to produce mechanically tight joints, the brazing alloy may penetrate the crystalline structure of the steel, causing brittleness and reduced ductility. Silver soldering is preferable to brazing if the work cannot be welded.

Welding. The stainless steels can be welded by all methods applicable to carbon steel except hammer or forge welding. Carbon arc welding is not recommended. As is the case with all materials, the heat generated during welding can affect physical or corrosion-resistant properties. Techniques that minimize heating of large areas of the work should therefore be used.

The austenitic grades are recommended for welding; welds are tough

and ductile. They have the same corrosion resistance as the base metal if the part is annealed after welding. In the absence of such post-weld annealing, a low carbon modification such as 304L or 316L, or a stabilized type such as 321 or 347 is used.

The ferritic stainless steels are not as weldable as the austenitics. But they can be welded by any commercial method except hammer or forge welding. If properly annealed they are tough, ductile and have good mechanical qualities, although not equal to those of the austenitics.

The hardenable martensitics can be welded by the special techniques used to weld tool steels and other high-alloy steels. They require pre-heating, post-heating or both, and a full anneal.

HEAT TREATING AND ANNEALING

None of the austenitic stainless steels is normally hardenable by heat treatment. High strength is obtained by cold working this group. Type 301 with its lower nickel-chromium ratio is particularly suited to work hardening in order to obtain high mechanical properties.

Normally, however, the austenitic stainless steels are used in the annealed condition. The metal then has the greatest resistance to corrosion, and is also very ductile and hence best suited for bending, forming and deep drawing. Most austenitic stainless is supplied already annealed. If in fabrication the material is cold worked to an undesirable extent, the piece can be annealed by heating to 1,950-2,050 F, followed by rapid cooling.

Ferritic stainless steels require moderate temperatures only for process annealing and stress relieving. Treatment of the medium chromium ferritic stainless steels differs somewhat from that of the higher chromium steels. For Type 430, with 14 to 18 per cent chromium, and for other ferritic stainless steels of the medium-chromium type, maximum ductility is obtained by holding at 1,400 to 1,500 F until the metal is heated through, followed by rapid cooling. This, of course, requires that the whole piece be annealed. When this is not possible or practical, heating the work to a dull cherry red using a blowtorch, followed by rapid cooling in air, will usually be satisfactory. For Type 446, with 23 to 27 per cent chromium, the piece should be heated through at 1,450 to 1,600 F, then cooled rapidly.

The martensitic stainless steels can be heat-treated to high strength and toughness. For the highest mechanical properties, the piece should be heated to 1,800 to 1,850 F and quenched in oil. Because of the low thermal conductivity, it should be heated slowly.

Table II—Heat Treating and Annealing of Stainless Steels

Form	Hardenability	Annealing Temperature, F	
		Full	Process
Austenitic, Unstabilized	Hardenable only through cold working	1,850–2,100 quick cool	1,800–2,050 quick cool
Stabilized	Hardenable only through cold working	1,850–2,050 air cool	1,550–1,650 air cool
Ferritic	Non-hardenable	1,450–1,550 air cool	1,200–1,525 air cool
Martensitic	1,750–1,950 F oil or air quench	1,500–1,650 slow cool	1,300–1,400 slow cool

Table III—Commercially Available Finishes for Stainless Steel Sheets

#1 Finish—Hot Rolled, Annealed and Pickled This is rarely used as a basic raw material for subsequent polishing or buffing, except in cases where forming and annealing would destroy higher mill finishes. It is used chiefly in heavier gages for industrial applications.

#2D Finish—Dull Cold Rolled Sheets are cold rolled after final annealing and pickling, and therefore have a much better finish than *#1*. Sheets with this finish have a compact, dense surface, as well as maximum ductility and drawing quality. This finish is considered by many to be most suitable for severe drawing operations. It is specified for most products that are to be buffed or polished after severe forming where no annealing will be involved.

#2B Finish—Bright Cold Rolled This finish is produced by a final light cold rolling between highly finished rolls. It has a dense surface that is brighter than #2D; is considered by some to be less suitable for extremely deep draws than a #2D finish. However, for less severe forming operations such as shallow draws, it offers a better surface on which to begin polishing operations.

#4 Finish—Standard Polish on One or Both Sides. Sheet surface is ground with successively finer abrasives, producing a uniform bright finish with good luster. It is suitable for shallow draws or moderate forming operations where original finish will not be destroyed or otherwise require finishing.

#6 Finish—Tampico-Brushed Finish This is a dull matte finish with a uniform, delicate, velvety texture. The satin finish is the result of both polishing and subsequent brushing.

#7 Finish—High Luster Polish This is a highly polished semi-mirror finish, more brilliant than #4.

TYPES OF FINISH

Requirements for finish on the stainless steels vary widely. Table II lists the surface finishes supplied by the primary sheet producer. It should be noted, however, that the appearance of a particular finish may vary somewhat with the different types of stainless steels.

All stainless steels have relatively smooth, dense surfaces, making finishing operations easy and economical. Type 430, for example, which currently is being used widely for automotive trim applications, usually requires only a small amount of buffing.

Grinding, polishing and buffing stainless steel present problems different from those encountered in handling other steels and non-ferrous metals. Since they conduct heat away more slowly than other steels, overheating should be avoided.

Stainless is also finished in many other ways, including darkened oxide finishes, electroplating, electrolytic polishing and painting.

TECHNICAL NEWS

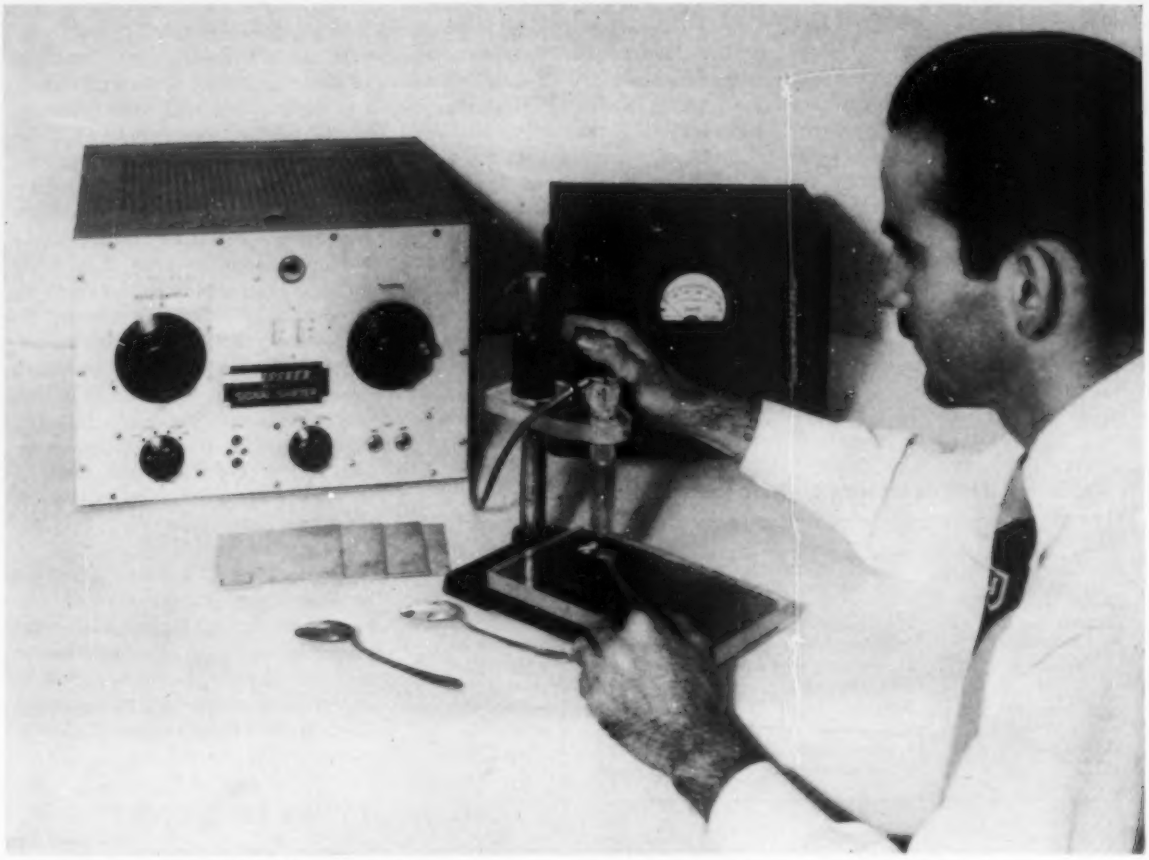


FIG. 1—The electronic NBS thickness gage, the Dermitron, offers a convenient means for measuring the thickness of plated coatings on silverware. It can be used for all types of metallic coatings, which differ from the basis metal in electrical conductivity.

Thickness Gages for Metallic Coatings

Not one, but three types of instruments for measuring the thickness of electrodeposited coatings have just been anounced by the National Bureau of Standards. While all three instruments have one thing in common, in that they depend upon the difference in electrical conductivity between the plating and the basis metal, each makes use of different methods for sensing specimen resistance. The Dermitron, Fig. 1, and the Phase-Angle Thickness Gage, Fig. 2, use an electromagnetic copuling to the specimen, making use of the reflected field from eddy currents induced in the specimen. The third, the Wave-Guide Plating Indicator, Fig. 3, employs direct conductivity measurement with a point electrode. When appropriately calibrated, they can be used for measurement of magnetic as well as non-magnetic materials.

The Dermitron makes use of the skin effect, by which an eddy current induced in a metallic surface can be limited to a thin surface layer, using a high-frequency current as an inducing agent. The depth of penetration of the current is inversely proportional to the square root of the frequency of the inducing current and directly proportional to the resistivity of the metal. If the coating and the basis metal have different conductivities, the effective conductivity of the composite surface layer, and consequently, the magnitude of the induced eddy current will depend to a large extent upon the thickness of the coating.

The range of thickness which can be measured by the Dermitron depends upon the frequency used. High frequencies are most suitable for accurate measurement of thin coatings, because the penetration current is shallower. At a frequency of 2 megacycles, most coatings up to 1.5 mils in thickness can be measured accurately. A frequency of 100 kilocycles permits coatings up to 6 mils to be measured, but measurements of thin deposits are not as accurate at this frequency as at 2 Mc. In practice, calibration curves

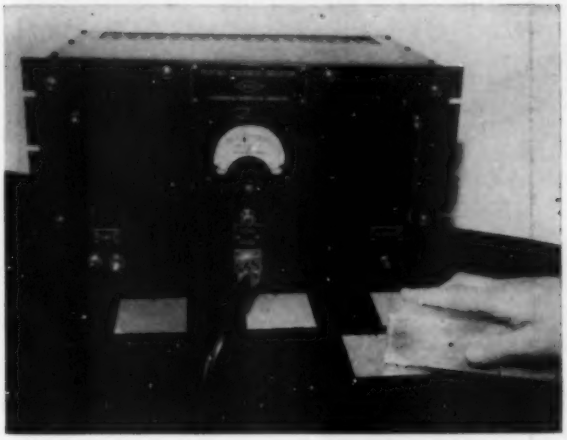


FIG. 2—The feature of the Phase-Angle thickness gage is its insensitivity to variations in the probe-to-sample spacing in determining the thickness of silver plating on a non-magnetic basis metal. Probe does not need to touch the sample.

FIG. 3—The Waveguide Plating Quantity Indicator measures from the outside the quantity of silver plating on the inside of an L-band waveguide. Conductance measuring techniques are used to determine the thickness of the internal plating.

are used which are made with specimens of known thicknesses.

The probe of the Phase-Angle Thickness Gage consists of a mutual inductance transducer which is held in proximity to the sample, but not necessarily touching it. A buckout transformer, shielded from the influence of the sample, is also located on the probe head. These two elements are electrically connected and excited with r-f current in opposition, producing output voltages whose phase difference is responsive to the conductance of the sample. A phase meter is calibrated for the desired frequency ranges.

NBS points out that the choice of operating conditions for a plating thickness meter is strongly influenced by the circumstances under which it is to be used, since the plating and basis metal both contribute to changes in the phase angle. For example, for a thin plating of low resistivity on a base metal of high resistivity, the problem is one of measuring the plating thickness alone. As the resistivities approach the same value (i.e., thinner basis and thicker plating), it becomes difficult to differentiate between the plating and the basis metal. However, this condition is not reached in the application for which the instrument is intended, since the resistivities of silver and stainless steel are greatly different.

The Waveguide Plating Quantity Indicator was designed specifically for measuring from the outside the quantity of silver plating on the inside of an L-band waveguide, but is useful for a wide variety of plating or thickness measurements. Its calibration is unaffected by the magnetic properties of the material under test.

The instrument actually measures the conductance of the silver deposited on the steel wall. Variations in the density and in the thickness of the silver cause a much greater change in the total conductance than similar variations in the steel.

Although the conductance measuring technique has been used before to make thickness measurements of homogeneous plate, the NBS instrument uses it to determine the thickness of one material of high conductivity plated on another material of low conductivity.

Besides being used to measure the quantity of internal plating in a waveguide, the indicating instrument can be used to determine the thickness of homogeneous metal sheets, to sort metals, and to rapidly measure the conductivity of metallic sheets of known thickness.

Bonding Fiberglas With Metal Gives New Structural Material

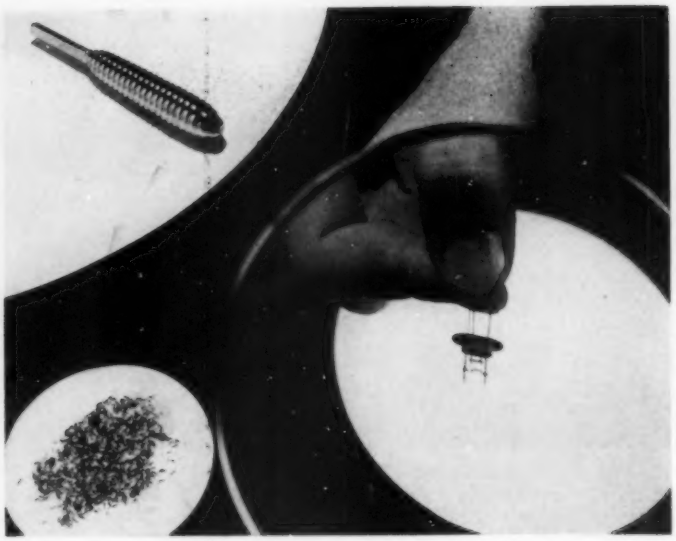
Instead of the conventional method of bonding Fiberglas with resins and organic materials, a new development under way at the Navy's Bureau of Ordnance combines metals and inorganic substances or combinations of both, with Fiberglas to give a reinforced structural material. The material, which is still unnamed, is expected to find use as tubing for the chemical and oil industries. Military applications are being studied.

According to the Navy, the process is this: Fiberglas filaments are formed in the usual way with bushings and refractory furnaces. As the filaments emerge from the furnace at high speeds, they are individually coated with metallic and other inorganic substances. Metal coatings, such as iron, nickel, molybdenum, aluminum, zinc, lead, tin and copper have been applied. The coated fibers are then bonded and compacted to form tubular products and laminates, in a subsequent process, which involves the application of heat and pressure.

Some of the advantages of the new material appear to be: suitable for higher temperatures than Fiberglas materials now available; has improved strength-weight ratio; it is highly resistant to the usual corrosive agents; and the raw materials necessary for the process are readily available.

The Navy is looking for industrial participation in further developments and uses for the material.

CRYSTAL GROWING a germanium ingot in a resistance-type furnace, the first step in the production of rate-grown transistors. About 2,000 transistors can be made from this ¼ lb ingot. Characteristics are produce during the drawing process.



THREE STEPS of transistor production. The quarter-pound ingot in the upper left was produced in two hours by the rate-grown method, then sliced into the small bars shown in the lower left. Each transistor bar measures 0.020 in. square by 0.1 in. long. This bar, with leads, becomes the transistor at right. A cap will be added and the unit hermetically sealed.

Transistors in Mass Production

Having just announced that it is tooling for mass production—in the millions—of low cost, exceptionally high frequency transistors, the General Electric Co. feels that the prices of these new devices should soon become competitive with vacuum tubes. Dr. W. R. G. Baker, G. E. Vice President, and General Manager of the Electronics Division, said that: "Plans for large quantity production has only been made possible through the development of a 'rate-grown' method of producing the transistor elements. Then, transistors should be available as soon as electronic equipment manufacturers have had sufficient circuitry development time to order them on a large quantity basis." Dr. Baker stressed the point that, "while this mass production is easily possible, it depends entirely on the speed with which the electronics industry can design the new circuitry and products using the high frequency transistors."

General Electric's rate-grown process involves introducing special impurities, gallium and antimony and varying the heat controls during the crystal growing process. By this method, as many as 100 wafer-thin layers of specially treated germanium in a 6 in. ingot are formed. The ingot is then diced into bars each several thousandths of an inch long with a layer through the center. The layer in the center of each bar does the work of a grid. The sections of the transistor bar on either side of the layer take the place of the cathode and plate in a tube. Using this new method, several thousand transistors can be produced from the yield of each ingot.

A feature of the rate-growing process is that conditions of single crystal germanium growth can be varied so that transistor bar having optimum operating characteristics can be varied at will, and in quantities of thousands at a time.

Electronic equipment using the new rate-grown transistors have been operated at temperatures above 190 F for hundreds of hours.

Problems, And More Problems

If you are looking for something to occupy your spare time, write to the U. S. Dept. of Commerce and ask for their bulletin, "Technical Problems Affecting National Defense". The new list of problems confronting the armed services was just compiled by the Department of Commerce's National Inventors Council with the aid of three military services.

Electronic problems include: a long-life battery for use in wide temperature ranges; a coaxial r-f switch; miniature hermetically sealed transistor cartridge; and a precision method for growth of large single silicon crystals.

Metal problems include: a protective coating for magnesium alloys; machinery for fabricating and welding titanium and metal-to-metal adhesives. A plastic problem is a liquid that will return a scratched and hazy acrylic plastic surface to its original clear state. Also: quick-cure casting resins and high temperature molding compounds.

Copies may be obtained from the National Inventors Council, U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C.

Scale Removal Problems Solved

With scale formation during heat treatment considered one of the serious problems accompanying the use of titanium and some types of stainless steel, Boeing Airplane Co. has helped the cause considerably with two new processes for scale removal which have been developed in their engineering process unit. The two processes are different from each other in that one chemically converts the scale to a form which will later simplify removal, while the other forms a physical barrier that inhibits scale formation.

According to Boeing, immersion of the scaled metal in 700-1,000 F molten salt baths presents a definite hazard. Currently, however, this is the most widely used method of dealing with the problem.

Boeing decided that the first step would be to apply a substance to the metal to act upon it during the heat treatment. It was finally found that certain carbonates combine with some nitrates, in the proper proportions, to give an effective crystalline coating. The nitrates present act as oxidizers and tend to convert the normal scale oxides into oxides of higher oxygen content, or different crystalline structure. TiO_2 in rutile form constitutes most of the scale in the moderate temperature range where most heat treatment is carried out. The oxidizing agent present in the precoating may change this rutile to a still higher oxide or perhaps a crystalline structure of the dioxide.

Boeing engineers think that the carbonates present in the pre-coating convert the normal scale oxides or the higher oxides into a titanate form which is not so hard to take off. The overall scale produced by the mixture may be a combination of higher oxides and titanates.

The new scale, produced by the coating and the heat treatment, appears to have a different coefficient of expansion from the metal surface; on cooling, part of its cracks and can be removed with a little rubbing. That scale remaining can be removed by a single brief pickle in a modified convential nitric-hydroflouric acid pickling solution.

For removing scale from stainless steels after heat treating, Boeing used a different approach. A silicon-bearing substance was found which decomposes in the furnace and deposits a coating of finely divided silica. This barrier of silica, which can be rinsed or brushed off after heat treating, greatly inhibits oxidation of the metal's surface.

Boeing found that when a stainless steel alloy 17-7 PH is heat treated at 1,400 F for 90 min and 1,100 F for an additional 90 min, it comes out with a thick scale. Pickling is not permitted at this time because it would induce intergranular corrosion. Generally sandblasting or a molten salt bath is used. With Boeing's silica treatment, the heat treat scale can be pickled off in two to four minutes following the above heat treatment of a stainless steel part.

New Process Increases Magnesium Corrosion Resistance

Because of magnesium's susceptibility to corrosion, its application, particularly in the aircraft industry, has been restricted. Attempting to find a solution to this problem, Nu-Line Plastic Impregnating Co. has developed a new impregnating process called Magseal, which they claim increases magnesium's resistance to corrosion by 300 to 400 per cent. Test samples of magnesium alloy castings and sheet impregnated with Magseal were subjected to a continuous salt spray for periods up to 125 hr with no evidence of pitting or failure.

Magseal is a resin combination which impregnates the metal just like conventional impregnation, yet which gives greater protection in the critical areas where dissimilar metals contact the magnesium.

In the process, after the metal is removed from the autoclave, all parts are rinsed in an alkaline type cleaning solution. Polymerization is done in a pressure bake oven at 275 F, under 100 psi. This heat does not allow the impregnant to weep, and all the resin is kept under the metal surface. From the oven, all parts are placed in another alkaline type "stripper" solution that completely removes any of the impregnating material from all surfaces, including tapped holes. This makes sure that all parts are free of residual resin without discoloration to parts, or affecting critical tolerances.

To date the process has been used on airborne radar equipment, and has been effective as a corrosion inhibitor.

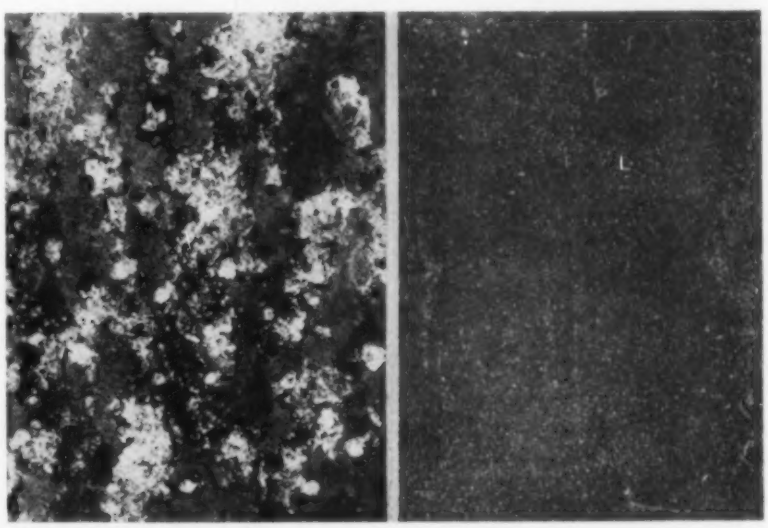
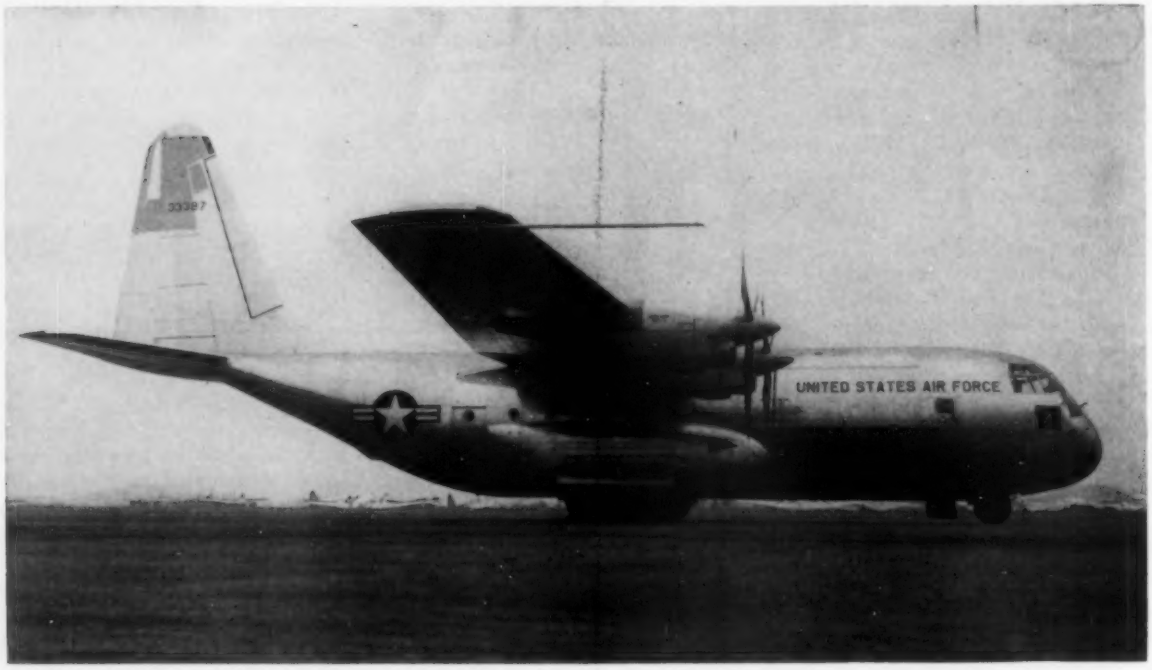


PHOTO ON LEFT shows an ordinary magnesium alloy casting, untreated and exposed to 32 hr of salt spray. Results were: corrosion at 6 hr; pits at 18 hr; and failure at 32 hours. Where bleaching shows in the illustration, the surface is almost gone. Photo of impregnated casting at right shows a comparison. At the end of 125 hr of salt spray, there was no pitting of the magnesium impregnated casting.

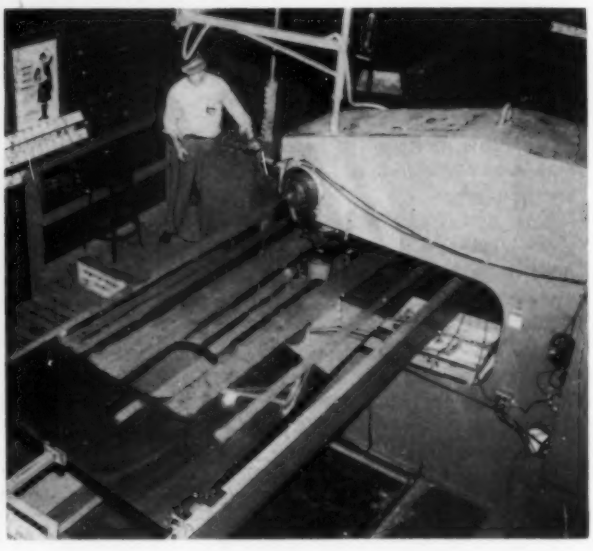
THE NEWS IN PICTURES

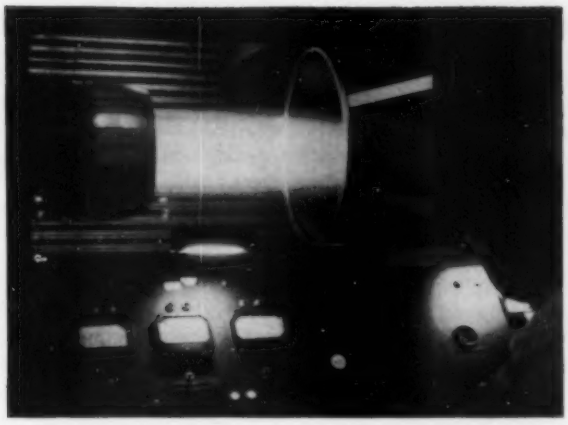


SHOWN READIED FOR ITS FIRST FLIGHT is the Air Force's YC-130 turboprop transport. Built by Lockheed Aircraft, and powered by Allison T-56 engines of 3,750 hp each, the transport can carry a bulldozer, a tank, a tractor trailer truck, or other items weighing 12 to 20 tons at speeds higher than any other transport. Unusual design of the low-slung fuselage features a floor the same height as the truck beds, and a high upswept tail for rear-end loading. Also, note the tandem main landing gear.

WHILE OUTWARDLY RESEMBLING a conventional microscope, this new device known as an "interference microscope" is being used at General Motors Research Lab. to measure surface peaks and valleys ranging from two to 100 millionths of an inch. Already the instrument has been used to measure plating thickness; to determine how plating materials smooth a surface by filling in irregularities; and to check corrosion pits and defects on cylinder bores and bearings.

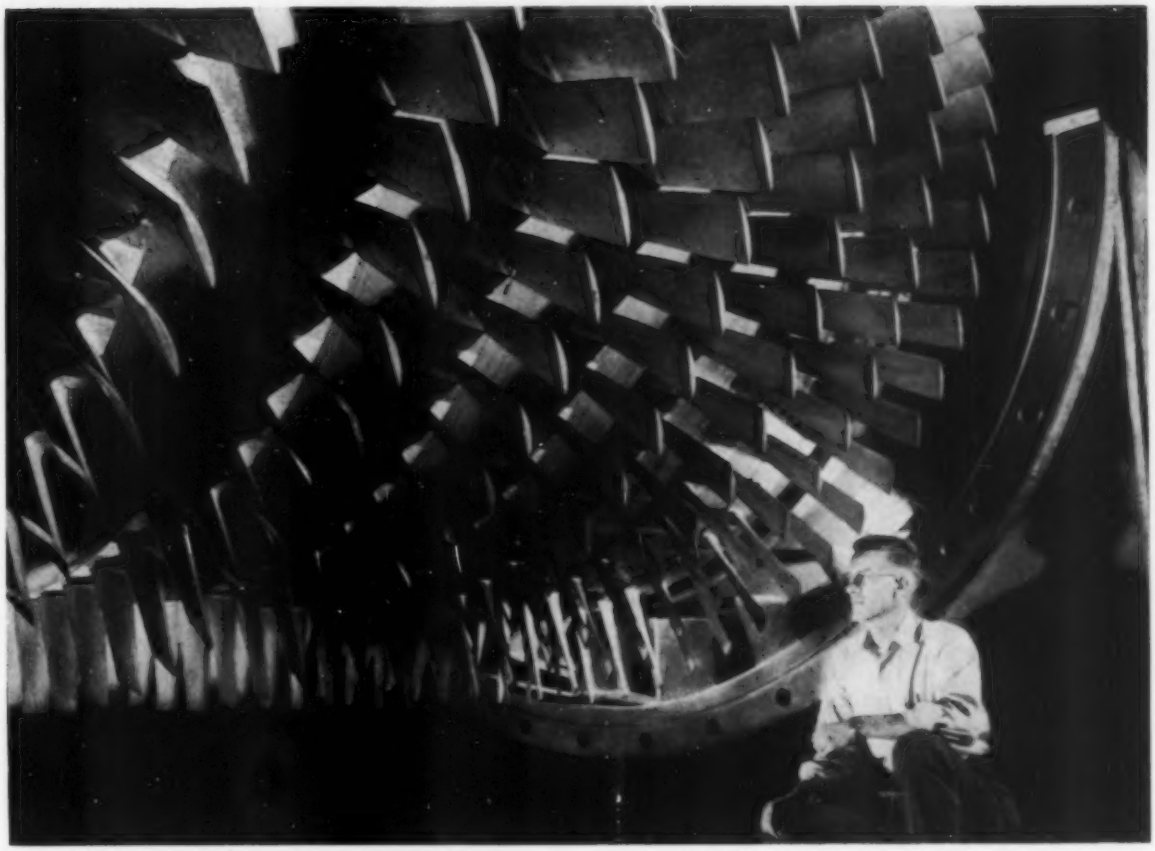
EXCEPT FOR THE ONE MAN who stands by as a safety factor, this film-controlled riveter is completely automatic. Developed by Convair and General Riveters, Inc., the machine also drills, countersinks, selects the proper rivet, inserts the rivet and sets it all from one starting signal. Heart of the machine is a 5-channel film-index control system. Five times as many automatic operations can be accomplished as compared with photoelectric indexing systems.





A BRIGHT PATH OF FLAME shoots through the chamber of North American Aviation's new sound abatement facility during afterburner tests of the F-100 Super Sabre's J-57 jet engine. In front of the technician are two observation windows made of four panels of bullet-proof glass. A 45 ft long muffler, 6 ft in dia catches some of the sound and is water-cooled to absorb almost all of the 3,500 F heat produced. Three feet thick walls of corrugated steel and separated by sand, absorb the rest of the noise.

ANSWERS for the preliminary designs of large power transformers that used to require 20 to 40 hr of manual calculation at General Electric Co., are now turned out in one hour with this card-programmed calculator. The calculator is able to produce answers bearing on transformer operations, such as variation of hotspot temperature under specified loading cycles and surrounding air temperature.



SIMULATING HIGH ALTITUDE FLIGHT CONDITIONS—the sub-atmospheric pressure and ultrasonic speeds encountered by jet aircraft—this Allis-Chalmers 1,000,000 cfm axial compressor rotor will be installed in the Ram Jet Addition of the Arnold Engineering Development Center. Each of two identical compressors, functioning as exhausters, will be driven by 24,500 hp synchronous motors and 6,000 hp wound rotor motors used for starting and supplementing the main drive motors.

TECHNICAL NEWS

More Adequate Use of Scientific Manpower Wanted

"Drafting graduate students who are studying scientific fields of practical military value is seriously endangering the defensive position of the United States," so said Professor Joseph O. Hirschfelder, of the University of Wisconsin, in a letter to U. S. Senator Alexander Wiley.

He said that the number of scientific graduate students in the nation's universities has been greatly reduced, with 3,500 being drafted last year. (See *Product Engineering*, August 1954, p. 198). Since only 10,700 graduate students get degrees in scientific subjects per year, it represents a severe decrease in the number of students being trained.

"Instead of drafting these young men," Prof. Hirschfelder said, "we should train them along military lines while they are going to school. We need now programs similar to the World War II programs called V-5, V-7 and V-12. In my opinion, a man with a graduate degree in science is far more useful than one whose training has been interrupted at a halfway level. I propose that regular graduate courses be given in various phases of ordnance, chemical warfare, military health programs, etc. In addition, I would suggest requiring them to spend three weeks each summer on a military post where they can become indoctrinated to military problems in a more concentrated fashion."

Professor Hirschfelder was also shocked at the scientific military manpower going to waste. He said, "I am appalled at the fact that no effort is being made to maintain the interest of these scientists who served in various military technological capacities during the past war. A sharp distinction has been drawn between the civilian scientists and those scientists who where in uniform. The uniformed scientists have been grouped together in special reserve officer units, and meet weekly to discuss military problems. In contrast, the civilian scientists have been permitted to forget all that they learned about miiitary applications."

Hirschfelder also suggested setting up a branch of the War College for the training of scientists in the special applications to military problems.

New Bill Gives NBS Fees For Outside Test Work

Introduced, but not voted on during the last session of Congress, was a bill by Senator Bricker which would allow the National Bureau of Standards to credit fees received for outside calibration and testing work to NBS operating funds, rather than to the general treasury.

The Scientific Apparatus Makers Association, which heartily endorses the bill, explained that at present, all costs for testing and calibration, including personnel, equipment and overhead, are amply paid for by those who benefit from the work.

However, under existing Bureau accounting procedures, all fees for this type of work bypass NBS, with the result that the government testing and standardization laboratories always show a monetary loss for this phase of their work.

Felts From Man-Made Fibers

What is there about wool or fur fibers which makes them Felt? Working from this question, scientists in the Textile and Industrial Products Research Div., of E. I. du Pont de Nemours & Co. went through all of the theories advanced to date concerning the felting of wool. Their end plan: to make felts from man-made fibers, such as Dacron polyester and Orlon acrylic fibers, which can be produced in a variety of deniers and accurately controlled shrinkages.

While the obvious approach would be to determine the fiber properties needed for felting and then select

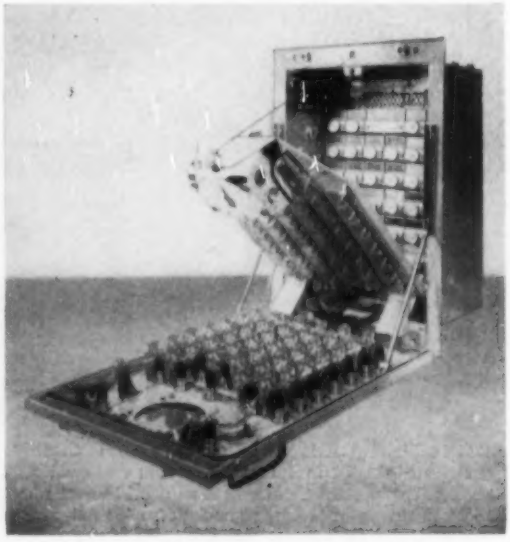
Monitor Guards Engine Bearings

By imbedding tiny, bead-like thermistors in the bearings of an engine, Minneapolis-Honeywell Regulator Co., with the cooperation of the Navy's Bureau of Ships, has put together a new robot temperature monitoring system capable of steadily monitoring 40 locations, usually in the turbine areas. The new transistorized system is a small, self-contained unit, as opposed to the conventional vacuum tube models now used which only scan the check points intermittently.

Operating 24 hr a day, the new system monitors all critical points and sounds an alarm and signal light when a bearing gets hot. By flipping a switch, an indicator gives the exact temperature reading.

Three transistors are used in each of the 40 amplifiers, with each amplifier being one-third the size and one-tenth the weight of a comparable vacuum tube system. The transistorized system draws less than 30 watts, in contrast to the 200 to 300 watt consumption of the vacuum tube unit.

Printed circuits are used wherever possible.



the fibers with the properties, or try to build the properties into a special fiber, such attempts in the past have failed. Du Pont scientists instead checked the purely mechanical part of felting: the interlocking and entangling.

The carpet trade for some time has used a device called a needle loom, which secures loose fibers to a woven base by punching with multiple needles. Recently, this technique has been used in the manufacture of high quality papermakers felts by punching nylon fibers into a woven base. Du Pont, then, decided that this needle-punching process might be used as a means of producing interlocking and entanglement, but without a base fabric. This process would then be followed by shrinkage, which can be induced in the fibers by the physical and chemical action of heat moisture and various chemicals. For example, after Dacron has once been exposed to the shrinking conditions and heat stabilized, it will undergo no further shrinkage when again exposed to shrinking conditions.

Thus, the fiber shrinkage, the amount of needle-punching, and the weight of the carded batt determine the characteristics of the felt—whether it will turn out hard or soft, and how strong. Consequently, a range of fiber shrinkages will be available to cover the entire felt spectrum, and the felt product is reproducible to a high degree of accuracy. The felts from Dacron are stronger, tougher, more durable and have higher abrasion resistance under many conditions than wool felts. Additional possibilities are a choice of fiber diameter, and of fiber cross section shape. Tests have indicated that the heavier denier fibers make superior polishing felts.

GE Forms Atomic Power Equipment Branch

The General Electric Co. has announced the forming of an Atomic Power Equipment Component which will market atomic power equipment for commercial use. The new Component will engineer, manufacture and sell various types of low power reactor systems, heat transfer and cooling system components, safety and remote-handling devices for radioactive materials, and other related atomic reactor equipment.

Low-power research reactors and components, intended primarily for use by educational, research, medical, and industrial organizations, can now be supplied, subject to the AEC laws. These various components can be integrated into a system to form a complete reactor installation. However, it was pointed out that these new low energy reactors can neither be used for producing commercial power, nor for making plutonium.

Flexible Ceramic Coatings

"Solution Ceramics" are what the Armour Research Foundation at Illinois Institute of Technology calls its new, flexible ceramic coatings. Differing from conventional coatings such as porcelain enamel. The new coatings are not brittle, and can be applied with a simple paint sprayer to almost any clean solid surface at a few hundred degrees Fahrenheit.

Called "solution ceramics" because they are applied from chemical solutions, the new coatings do not contain any adhesive or binding agent, and can be easily applied in films as thick as 0.01 in. or as thin as a few millionths of an inch. The temperature required by the coating process is far lower than that required for porcelain enamel. The coatings are highly resistant to heat, and the more refractory ones can be used to protect a metal, for instance, against molten metal or slag. And, the coatings are not as hard as the ordinary ceramic materials, permitting sheet metals to be coated and stamped afterwards.

There are many different solution ceramics. The coatings most intensively studied to date are refractory metal oxides—zirconia, chromia, titania, magnesia and similar materials. However, the process is not limited to these of these compounds. Certain phosphates, silicates, fluorosilicates, oxyhalides, and even metals can be deposited in this way. And two or more of the materials can be co-deposited or applied in separate layers to the base metal being coated.

News Briefs

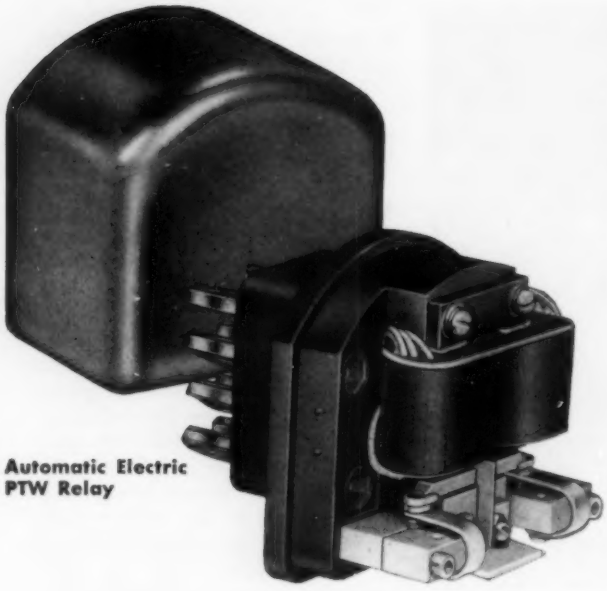
A new addition to Minneapolis-Honeywell Regulator Company's line of pneumatic control system components is a pneumatic relay that can multiply a proportional outgoing pressure. Called the Tel-O-Set automatic ratio relay, it was developed primarily for applications in the chemical, petroleum and metal processing industries.

The new relay receives two pressure signals of from 3 to 15 psi each and transmits an output pressure that is proportional to the primary input pressure. The proportionality factor, or ratio, between output and input is adjusted by the second input pressure. The maximum range of ratios is 0 to 2.0, which corresponds to the 3 to 15 psi change in ratio setting pressure. However, the ratio span may pressure. Internal adjustment screws permit other ratio spans.

Fort Belvoir, Virginia, has been picked as the site for an experimental, full-scale, but small nuclear power plant to be designed and built jointly by the Army Corps of Engineers and the AEC. The plant is the prototype of a "package" or transportable power reactor which is being developed for use at remote bases, eliminating the need to transport bulky conventional fuels. The reactor, is of the "pressurized-water" type, and the plant, with a capacity of about 1,700 kw, will be built of components transportable by air.

New polar relay...

sensitive, rugged, compact!



Automatic Electric
PTW Relay

Here's a new polar relay that will soon be setting records for long service life! Its sensitivity gives peak performance for high-speed polarized pulse repeating, or for applications where low current is transmitted over long lines. The Series PTW Relay is also recommended for line-current direction indication or as a differential relay in the "Wheatstone Bridge" type of control. Advanced features include:

simplified design and long service life

New design eliminates many parts and adjustments formerly required. Relay gives *billions* of operations without re-adjustment.

extreme sensitivity

Unit operates on currents as low as 2 to 12 milliamperes, depending upon number and combination of windings used. Signals as low as 10 milliwatts through the two line-windings will "trigger" the relay.

reduced bounce and wear

A new method of armature support limits longitudinal movement. There are no bearings to wear . . . the usual rocking motion in contact make-and-break is reduced. Armature bounce is virtually eliminated; contacts last longer.

improved characteristics in smaller size

Because of increased magnetic efficiency, the coils take less space and need fewer turns. The lower coil impedance of this compact unit gives improved characteristics.

fast response

Travel time is as low as .9 milliseconds, depending upon contact gap and windings used.

send for circular

For a small, fast, sensitive polar relay that out-performs and outlasts all others, specify this new Automatic Electric Series PTW Relay. For details ask for Circular 1821. Write: Automatic Electric Sales Corporation, 1033 West Van Buren St., Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto. Offices in principal cities.

helpful technical data

Make and Break—75% total "make" on both contacts at 60 cycles per second with .006" contact gap and 23 milliamperes of sine wave ac. Simple, easy re-adjustment can be made in the field.

Windings—Four windings: two line-windings, each 139 ohms resistance and only .5 henry inductance; other two windings, each 101 ohms and .125 henry. The number of coil turns to be placed in series aiding can vary from 1400 to 8400.

Cover—Snap-on cover easily removed for inspection and adjustment of relay.

Mounting—Jack mountings, available for flush or surface mounting.

Size—2¼" wide, 2½" deep and 2 11/16" high (plus 5/16" projection of banana plugs).

For more detailed information, ask for Circular 1821.

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

Buckling and Moment Table for Steel Beams

L. P. HOLLINGSWORTH

THESE DATA were assembled: (1) to eliminate cut-and-try methods of selecting the most economical shape for laterally unsupported beams; (2) to reduce the number of steps normally required to determine the necessary and most economical section for a steel beam; and (3) eliminate the need for solving buckling formulas.

Beam shapes are arranged in descending order of section modulus to facilitate the selection of economical shapes. Buckling moduli are based on an allowable compressive stress on extreme fibers of 20,000 psi with $L'd/bt$ equal to or less than 600. It $L'd/bt$ is greater than 600, allowable compressive stress must be reduced in accordance with the following equation:

$$f = (12{,}000{,}000)\,\frac{bt}{L'd}$$

where L' unsupported length, in.
d depth of member, in.
b width of compression flange, in.
t thickness of compression flange, in.
f allowable stress, psi

METHOD OF USING THE TABLE

1. Find the moment required.
2. Enter table under *M*, the allowable moment.
3. Find the first shape marked with an asterisk which has an *M* value larger than the required moment. This is the most economical shape for laterally supported beams.
4. Compare laterally unsupported span with L_u in table. L_u is the maximum beam length in feet allowable not requiring stress reduction for lateral unsupport.
5. If the laterally unsupported span exceeds L_u, compute the buckling modulus required.

$$B = \frac{ML}{83.33}$$

M = moment, ft-kips.
L = laterally unsupported length, ft.

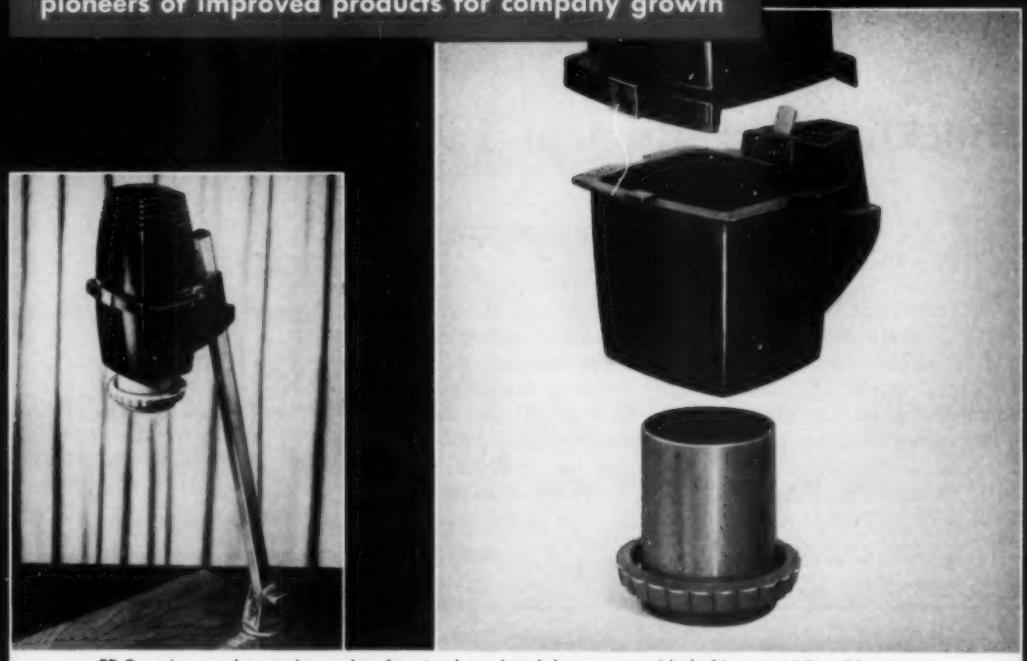
6. Under *B* in the table, find the next most economical shape which has a higher value than the required buckling modulus. This will be the best shape to use to satisfy design conditions.

SHAPE	S	M	Lu	B
36 WF 300	1105.1	1842	38	844
36 WF 280	1031.2	1719	35.5	737
36 WF 260	951.1	1585	32.5	626
36 WF 245	892.5	1488	30.5	551
*36 WF 230	835.5	1393	28.5	483
33 WF 240	811.1	1352	33	537
*33 WF 220	740.6	1234	30	449
14 WF 426	707.4	1179	135	1917
*33 WF 200	669.6	1116	27	368
*36 WF 194	663.6	1106	20.5	278
14 WF 398	656.9	1095	128.5	1692
30 WF 210	649.9	1083	32.5	425
*36 WF 182	621.2	1035	19.5	244
14 WF 370	608.1	1014	122	1484
30 WF 190	586.1	976.8	29.5	347
*36 WF 170	579.1	965.2	18	212
14 WF 342	559.4	932.3	114.5	1287

SHAPE	S	M	Lu	B
*36 WF 160	541.0	901.7	17	184
30 WF 172	528.2	880.3	26.5	282
14 WF 314	511.9	853.2	107	1104
*36 WF 150	502.9	838.2	15.5	158
27 WF 177	492.8	821.3	30.5	302
14 WF 320	492.8	821.3	104	1025
33 WF 152	486.4	810.7	18	178
14 WF 287	465.5	775.8	100	935
*33 WF 141	446.8	744.7	16.5	148
27 WF 160	444.5	740.8	27.5	247
14 WF 264	427.4	712.3	94	804
24 WF 160	413.5	689.2	32	267
*33 WF 130	404.8	674.7	15	120
27 WF 145	402.9	671.5	25	205
14 WF 246	397.4	662.3	89	707
30 WF 132	379.7	632.8	17.5	132
14 WF 237	382.2	637.0	86	659
24 WF 145	372.5	620.8	29	218
14 WF 228	367.8	613.0	83.5	616

(continued on page 213)

THE DESIGNER AND ENGINEER:
pioneers of improved products for company growth



FR Corp.'s new photo enlarger lens housing barrel and sleeve are molded of Lustrex Hi-Test 88 styrene; upper housing of Resinox phenolic plastic.

FR's designers create first low-cost, quality enlarger with HI-TEST 88 MONSANTO LUSTREX Styrene Plastics

The FR Corporation's new photo enlarger is a notable example of how sound, functional design in plastics can slash production, finishing and assembly costs – savings that made possible an inexpensive, quality instrument aimed at a big, untapped market.

The lens housing barrel and sleeve are molded of Monsanto's Lustrex Hi-Test 88 styrene – and they're classics of engineered economy. Complex shapes that would be difficult, time-consuming and expensive to fabricate by conventional processes are quickly formed in a "one-shot" molding operation with Lustrex Hi-Test 88 styrene . . . *and at a cost far below that of designs in other materials!* Ready for assembly when it comes from the mold – *no finishing needed!*

The FR enlarger's upper housing, made of Monsanto's Resinox phenolic plastic, contains a high intensity, low-wattage lamp which produces plenty of heat . . . sure death to most materials. *But not to Resinox!* It's ruggedly resistant to heat, resists chipping and rusting. FR's designers also know that Resinox molds with flawless quality, eliminating costly finishing.

Modern designers and engineers plus Monsanto plastics are ideal teammates for greater products and bigger profits for your company! Write for full information on Monsanto plastics to:
MONSANTO CHEMICAL COMPANY,
Plastics Division, Room 2111,
Springfield 2, Mass.

Resinox: Reg. U. S. Pat. Off.

Meet more Monsanto products on the CBS-TV "Morning Show"

MONSANTO

SERVING INDUSTRY . . . WHICH SERVES MANKIND

PRODUCT ENGINEERING—REFERENCE BOOK SHEET

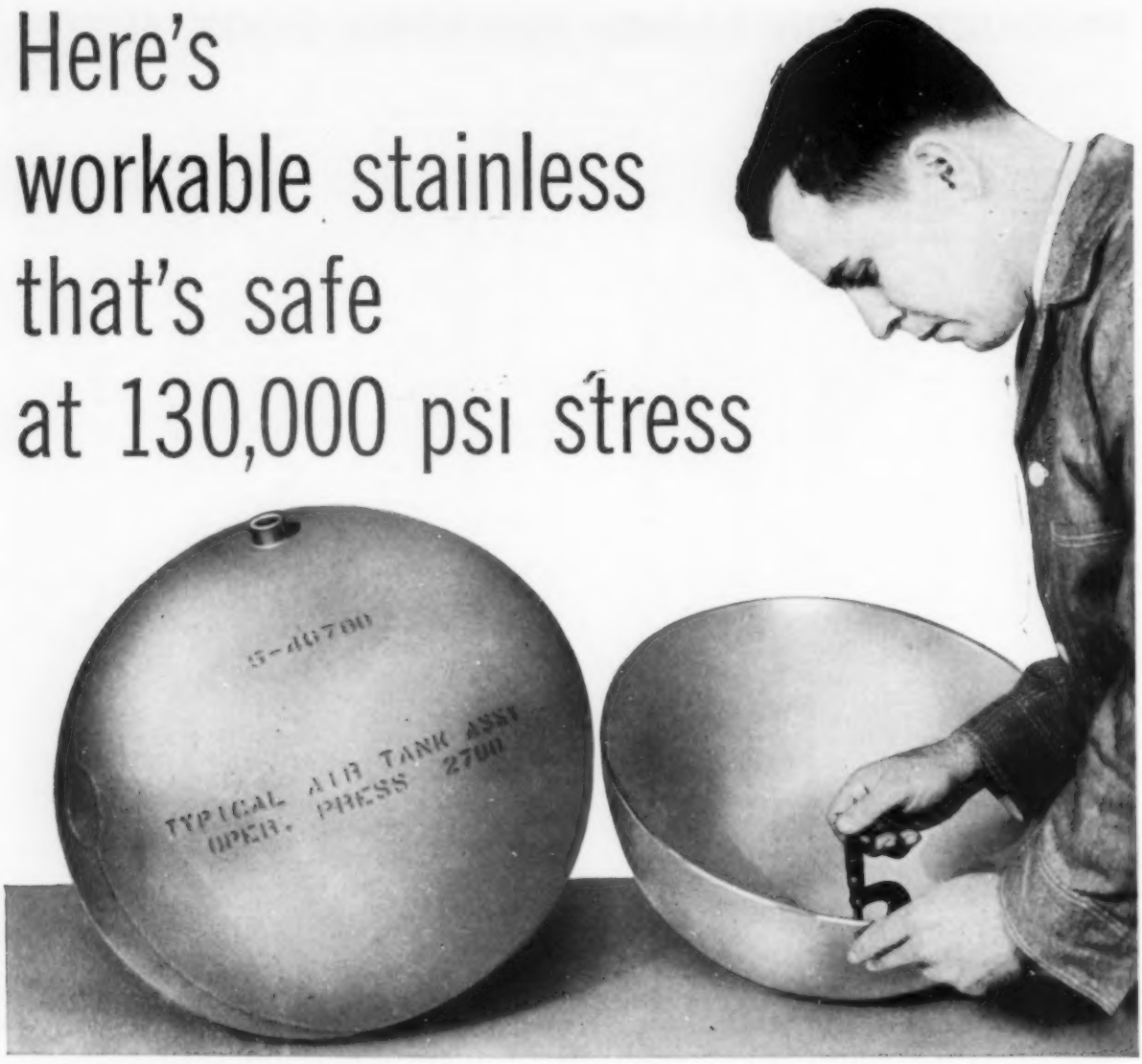
(Continued from page 211)

SHAPE	S	M	Lu	B
*30 WF 124	354.6	591	15	115
14 WF 219	352.6	587.7	80.5	571
14 WF 211	339.2	565.3	78	532
24 WF 130	330.7	551.2	26	171
*30 WF 116	327.9	546.5	15	97.6
14 WF 202	324.9	541.5	75.5	492
21 WF 142	317.2	528.7	33.5	213
14 WF 193	310.0	516.7	72.5	452
*30 WF 108	299.2	498.7	13	80.0
27 WF 114	299.2	498.7	17	103
24 WF 120	299.1	498.5	23	138
14 WF 184	295.8	493.0	70	455
21 WF 127	284.1	473.5	30	172
14 WF 176	281.9	469.8	67	380
24 WF 110	274.4	457.3	21	117
14 WF 167	267.3	445.5	64	344
*27 WF 102	266.3	443.8	15	81.4
12 WF 190	263.2	438.7	76.5	403
14 WF 158	253.4	422.3	61.5	312
24 I 120	250.9	418.2	18.5	92.6
21 WF 112	249.6	416.0	27	133
*24 WF 100	248.9	414.8	19	96.5
*27 WF 94	242.8	404.7	13.5	67.3
14 WF 150	240.2	400.3	58.5	283
24 I 105.9	234.3	390.5	18	84.9
14 WF 142	226.7	377.8	55.5	253
12 WF 161	222.2	370.3	67	298
*24 WF 94	220.9	368.2	16	72.0
18 WF 114	220.1	366.8	31.5	139
14 WF 136	216.0	360.0	53	229
18 WF 105	202.2	337.0	29	118
14 WF 127	202.0	336.7	50	203
21 WF 96	197.6	329.3	20	79.0
24 I 100	197.6	329.3	13	51.9
*24 WF 84	196.3	327.2	14.5	56.6
14 WF 119	189.4	315.7	47	179
24 I 90	185.8	309.7	13	48.0
18 WF 96	184.4	307.3	27	99.1
12 WF 133	182.5	304.2	57	208
14 WF 111	176.3	293.8	44	156
*24 WF 76	175.4	292.3	12.5	45.0
24 I 79.9	173.9	289.8	12.5	44.1
21 WF 82	168.0	280.0	17	57.3
16 WF 96	166.1	276.8	31	102.5
14 WF 103	163.6	272.7	41	136
12 WF 120	163.4	272.3	52	170
20 I 95	160.0	266.7	16.5	52.8
18 WF 85	156.1	260.2	22	68.5
16 WF 88	151.3	252.2	28	85.5
*21 WF 73	150.7	251.2	14.5	43.6
14 WF 95	150.6	251.0	38	116
20 I 85	150.2	250.3	16	48.6
12 WF 106	144.5	240.8	46.5	135
18 WF 77	141.7	236.2	20	56.9
*21 WF 68	139.9	233.2	13.5	37.5
14 WF 87	138.1	230.2	35.5	98.6
12 WF 99	134.7	224.5	44	118.6
14 WF 84	130.9	218.2	33	86.1
18 WF 70	128.2	213.7	18	46.8
16 WF 78	127.8	213.0	23	58.9

SHAPE	S	M	Lu	B
*21 WF 62	126.4	210.7	12	30.5
20 I 75	126.3	210.5	12.5	31.8
10 WF 112	126.3	210.5	57	144.3
12 WF 92	125.0	208.3	41	103.1
14 WF 78	121.1	201.8	30.5	74.3
18 WF 64	117.0	195.0	16.5	39.1
20 I 65.4	116.9	194.8	12	28.9
16 WF 71	115.9	193.2	21	48.7
12 WF 85	115.7	192.8	38	89.7
10 WF 100	112.4	187.3	51.5	116.9
14 WF 74	112.3	187.2	28	62.4
*18 WF 60	107.8	179.7	14.5	31.0
12 WF 79	107.1	178.5	36	77.1
16 WF 64	104.2	173.7	19	39.6
14 WF 68	103.0	171.7	25.5	52.8
18 I 70	101.9	169.8	12	24.4
10 WF 89	99.7	166.2	47	94.0
*18 WF 55	98.2	163.7	13	25.7
12 WF 72	97.5	162.5	33	64.1
16 WF 58	94.1	156.8	17	32.3
14 WF 61	92.2	153.7	23	42.7
*18 WF 50	89.0	148.3	12	21.1
18 I 54.7	88.4	147.3	11.5	20.3
12 WF 65	88.0	146.7	30	52.7
10 WF 77	86.1	143.5	41.5	71.7
*16 WF 50	80.7	134.5	13.5	22.0
10 WF 72	80.1	133.5	39	62.7
12 WF 58	78.1	130.2	26	41.1
14 WF 53	77.8	129.7	19	29.6
18 ** 58	74.5	124.2	——	——
10 WF 66	73.7	122.8	36	53.8
*16 WF 45	72.4	120.7	12	17.79
12 WF 53	70.7	117.8	24	33.8
14 WF 48	70.2	117.0	17	24.2
18 ** 51.9	69.1	115.2	——	——
10 WF 60	67.1	118.8	33.5	45.0
12 WF 50	64.7	107.8	21	27.5
*16 WF 40	64.4	107.3	11	14.19
15 I 50	64.2	107.0	11.5	15.00
18 ** 45.8	63.7	106.2	——	——
14 WF 43	62.7	104.5	15.5	19.35
18 ** 42.7	61.0	101.7	——	——
10 WF 54	60.4	100.7	30.5	37.1
8 WF 67	60.4	100.7	43	51.9
15 I 42.9	58.9	98.2	11	13.42
12 WF 45	58.2	97.0	19	22.4
*16 WF 36	56.3	93.8	9.5	10.62
14 WF 38	54.6	91.0	12.5	13.45
10 WF 49	54.6	91.0	28	30.5
15 ** 50	53.6	89.3	——	——
8 WF 58	52.0	86.7	38	39.5
12 WF 40	51.9	86.5	17.5	17.96
12 I 50	50.3	83.8	15	15.15
10 WF 45	49.1	81.8	24.5	24.07
*14 WF 34	48.5	80.8	11	10.60
15 ** 40	46.2	77.0	——	——
12 WF 36	45.9	76.5	14.5	13.30
12 I 40.8	44.8	74.7	14.5	12.91
8 WF 48	43.2	72.0	32.5	28.2
10 WF 39	42.2	70.3	21	17.88

(continued on page 215)

Here's workable stainless that's safe at 130,000 psi stress



This stainless steel pressure vessel operates under an average stress of 130,000 psi . . . is tested at a calculated stress of 169,000 psi.

Of course, the shell is constructed of a special stainless steel — Armco 17-7 PH — a precipitation-hardening type made only by Armco. The two halves are readily drawn and welded while the steel is in the annealed condition. The finished assembly is then hardened by double precipitation-hardening heat treatment.

This is the procedure for hardening Armco 17-7 PH. It is first held at 1400 degrees F for 1½ hours, then cooled to 60 degrees F or lower. After that comes a second heat treatment at 950-1050 F for ½-hour and air cooling.

WELDS STRONG TOO

The result of this double heat treatment is a minimum yield strength of 150,000 psi and tensile strength of 180,000 psi or higher. Welds have this same strength when made by the inert-gas shielded-arc system.

If you need a stainless steel with easy workability, high strength, endurance and fatigue resistance, write for information on the Armco Precipitation-Hardening Stainless Steels. Besides Armco 17-7 PH there is the single heat treatment precipitation-hardening bar grade, Armco 17-4 PH.

ARMCO STEEL CORPORATION
4944 CURTIS STREET, MIDDLETOWN, OHIO

ARMCO®

SHEFFIELD STEEL • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

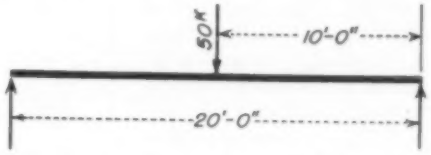
PRODUCT ENGINEERING—REFERENCE BOOK SHEET

(Continued from page 213)

SHAPE	S	M	Lu	B
*14 WF 30	41.8	60.7	9.5	7.78
15 ** 33.9	41.7	69.5	——	——
12 WF 31	39.4	65.7	12.5	9.90
12 I 35	37.8	63.0	11.5	8.71
12 I 31.8	36.0	60.0	11.5	8.16
8 WF 40	35.5	59.2	27	19.4
10 WF 33	35.0	58.3	17.5	12.37
*12 WF 27	34.1	56.8	10.5	7.41
8 WF 35	31.1	51.8	24	15.17
10 WF 29	30.8	51.3	14	8.75
10 I 35	29.2	48.7	12	7.09
8x8 M 34.3	28.9	48.2	21.5	12.64
8 WF 31	27.4	45.7	21.5	11.86
12 ** 30	26.9	44.8	——	——
*10 WF 25	26.4	44.0	12	6.47
*12 B 22	25.3	42.17	7	3.51
10 I 25.4	24.4	40.67	11.5	5.58
8 WF 28	24.3	40.50	18.5	9.14
12 ** 25	23.9	39.83	——	——
10 M 25	23.6	39.33	11	5.24
8 M 28	22.5	37.50	15	7.03
*10 M 21	21.7	36.17	11	4.72
*10 WF 21	21.5	35.83	10	4.24
*12 B 19	21.4	35.67	5.5	2.46
12 ** 20.7	21.4	35.67	——	——
8 M 24	21.0	35.00	15	6.36
8 WF 24	20.8	34.67	16	6.78
10 ** 30	20.6	34.33	——	——
*10 B 19	18.8	31.33	7.5	2.89
10 ** 25	18.1	30.17	——	——
*12 B 16.5	17.5	29.17	4.5	1.56
8 WF 20	17.0	28.33	12	4.17
6 WF 25	16.8	28.00	21.5	7.31
10 B 17	16.2	27.00	6.5	2.10
8 I 23	16.0	26.67	11	3.55
10 ** 20	15.7	26.17	——	——
6x6 M 25	15.7	26.17	24.5	7.77
8 M 20	15.2	25.33	10	3.17
*12 B 14	14.8	24.67	3.5	1.10
8 I 18.4	14.2	23.67	10.5	3.01
8 WF 17	14.1	23.50	10	2.85
8 M 17	14.0	23.33	10	2.86
10 B 15	13.8	23.00	5.5	1.48
9 ** 20	13.5	22.50	——	——
10 ** 15.3	13.4	22.33	——	——
6 WF 20	13.4	22.33	17.5	4.77
6x6 M 20	12.9	21.50	18.5	4.79
*12 Jr 11.8	12.0	20.00	3	0.75
7 I 20	12.0	20.00	11	2.60
8 B 15	11.8	19.67	7.5	1.82
9 ** 15	11.3	18.83	——	——
8 ** 18.75	10.9	18.17	——	——
*10 B 11.5	10.5	17.50	4	0.854
9 ** 13.4	10.5	17.5	——	——
7 I 15.3	10.4	17.33	10	2.13
6 WF 15.5	10.1	16.83	13	2.72
6 B 16	10.1	16.83	13	2.66
5 WF 18.5	9.94	16.57	20.5	4.10
8 B 13	9.88	16.47	6	1.25

SHAPE	S	M	Lu	B
*11 Jr 10.3	9.6	16.00	2.5	0.480
5x5 M 18.9	9.5	15.83	21.5	4.16
12 Jr** 10.6	9.3	15.50	——	——
8 ** 13.75	9.0	15.00	——	——
6 I 17.25	8.7	14.50	10.5	1.86
5 WF 16	8.53	14.22	17.5	3.07
8 ** 11.5	8.1	13.50	——	——
*10 Jr 9	7.8	13.00	2.5	0.39
8 B 10	7.79	12.98	5	0.795
7 ** 14.75	7.7	12.83	——	——
6 I 12.5	7.3	12.17	10	1.45
6 B 12	7.24	12.07	9	1.34
7 ** 12.25	6.9	11.5	——	——
*10 Jr** 8.4	6.5	10.83	——	——
7 ** 9.8	6.0	10.00	——	——
5 I 14.75	6.0	10.00	10.5	1.28
*9 Jr 7.5	5.8	9.67	2.5	0.29
6 ** 13	5.8	9.67	——	——
4 WF 13	5.45	9.08	16.5	1.84
4x4 M 13	5.2	8.67	18	1.92
6 B 8.5	5.07	8.45	6.5	0.658
6 ** 10.5	5.0	8.33	——	——
5 I 10	4.8	8.00	10	0.94
*8 Jr 6.5	4.7	7.83	2.5	0.247
10 Jr** 6.5	4.4	7.33	——	——
6 ** 8.2	4.3	7.17	——	——
4 WF 10	4.16	6.93	13	1.10
*7 Jr 5.5	3.5	5.83	2.5	0.194
5 ** 9	3.5	5.83	——	——
4 I 9.5	3.3	5.50	10	0.675
5 ** 6.7	3.0	5.00	——	——
4 I 7.7	3.0	5.00	9.5	0.585
*6 Jr 4.4	2.4	4.00	3	0.141
4 ** 7.2	2.3	3.83	——	——
4 ** 5.4	1.9	3.17	——	——
3 I 7.5	1.9	3.17	11	0.413
3 I 5.7	1.7	2.83	10	0.343
3 ** 6	1.4	2.33	——	——
3 ** 5	1.2	2.00	——	——
*3 ** 4.1	1.1	1.83	——	——

**—*Refers to channel section.*



EXAMPLE: A 20 ft laterally unsupported beam carries a concentrated load at its midspan of 50,000 lb.

Solution: $M = \frac{PL}{4} = \frac{50 \times 20}{4} = 250$ ft kips

The first economical shape above M=250 is 21 WF 73 with Lu=14.5 (which is less than 20). Compute the buckling modulus.

$$B = \frac{250 \times 20}{83.33} = 60$$

The next most economical beam is therefore 18 WF 85 with B=68.5.

Modular Wiring Ducts for Control Panels

Laminated plastic wiring ducts, modular in design, are being made for use in electrical control panels, electronic equipment and similar applications where extensive, complicated wiring must be systematized and protected. The manufacturer reports that time studies have indicated reductions in labor time of 25 to 50 percent are possible with this new wiring apparatus.

The new ducts consist of modular side and end panels (perforated to provide easy entrance and exit of connections to and from electrical or electronic components), covers and cover clips. These clips are of the snap-on-type and provide a hinge action to facilitate removing and replacing the cover.

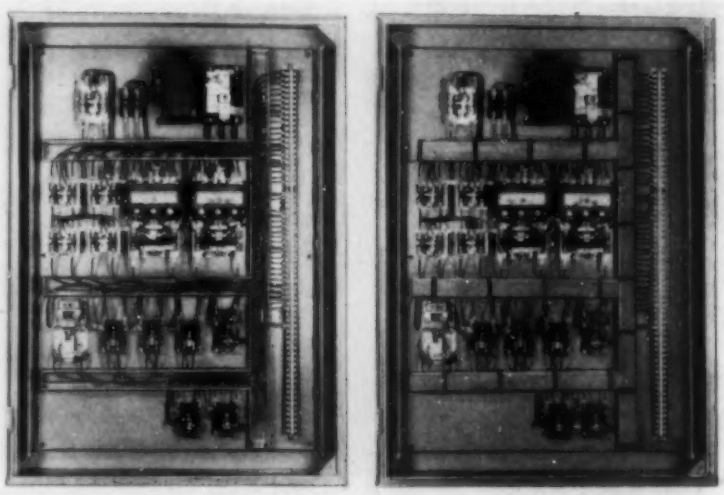
The side and end panels are first cut to size. Then they are assembled, with fastenings being applied through pre-punched holes into the control panel or board. Locating of screw holes in board is facilitated by templates supplied by the maker of the ducts. Special joint and corner clips add rigidity and facilitate joining of sides and end duct panels.

The ducts are then ready for wires to be connected and laid. Wires are pulled through the correct lead-off holes in the sides of the ducts and connected to the proper components. Covers are snapped in place to complete assembly.

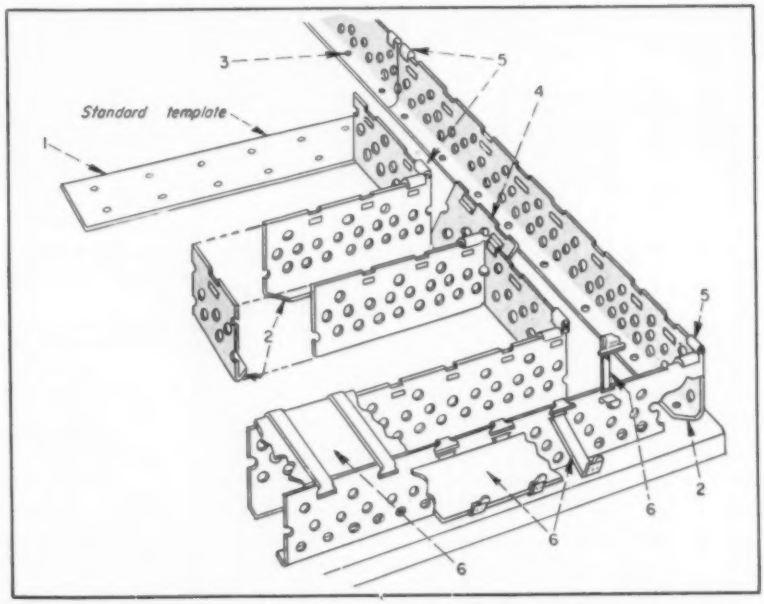
There new wiring ducts come in black or natural colors and have a glossy finish. They are asserted to be able to protect wiring from mechanical damage and to give additional protection in event of insulation failure.

To provide for easy maintenance or wiring changes, the clips that hold covers in place swing back, completely exposing all wiring. Covers do not have to be removed from panel and unlacing wires is eliminated. Wiring changes are only a matter of minutes. Stahlin Brothers Fibre Works, Inc., Belding, Mich.

For more information—
Circle 1, inside back cover



PLASTIC DUCTS have been installed and wiring laid in them in view at left. At right, covers have been installed, completely enclosing the wiring.



HOW THE NEW WIRING DUCTS are assembled: **(1) Layout and drill mounting holes. (2) Cut side angle and end piece to desired length; mitre mounting leg and ends for proper fit. (3) Fasten side angles to panel with screws or other fastenings. (4) Make cut-out on side angle for "T" junctions. Cut to, but do not remove, mounting leg. (5) Install joint clips on butt joints and at corners. Crimp with pliers if desired. (6) Insert cover hinge clips at approximate 6 to 8 in. spacing. Press fit covers firmly into clip. Close cover and snap into locked position.**

Screw Driver Installs Retaining Ring

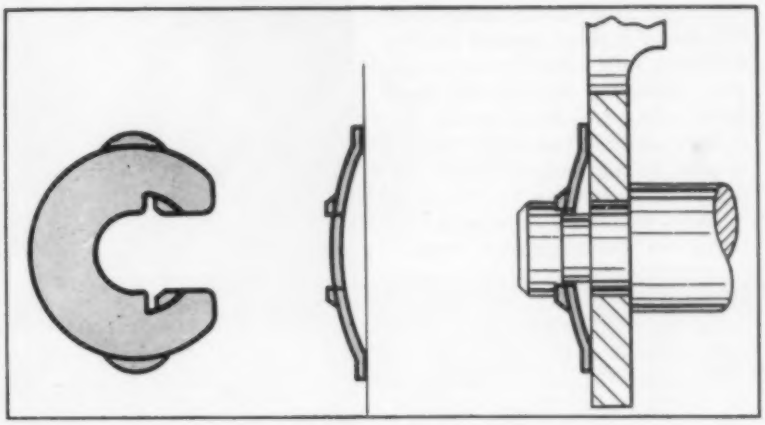
A new radially-applied retaining ring which can be locked positively in its groove and used as a shoulder against rotating parts is intended for use in the automotive, electronic and aeronautical industries. The new ring is made of spring steel and is shaped like a bowed horseshoe. When fastened to a shaft it is locked in its groove by two prongs extending from the inner circumference of the open end.

The ring is manufactured in sizes to accommodate shafts ranging in diameter from $\frac{1}{8}$ to $\frac{1}{2}$ in. with larger sizes available for special applications. Because it is assembled radially and may be seated in a deep groove, the ring is said to provide for high thrust load capacities. Shear strength ranges from 500 lb for the $\frac{1}{8}$ in. ring to 2,500 lb for the $\frac{1}{2}$ in. ring. The fastener is positive-locking against radial displacement and it can be assembled and disassembled with a screwdriver.

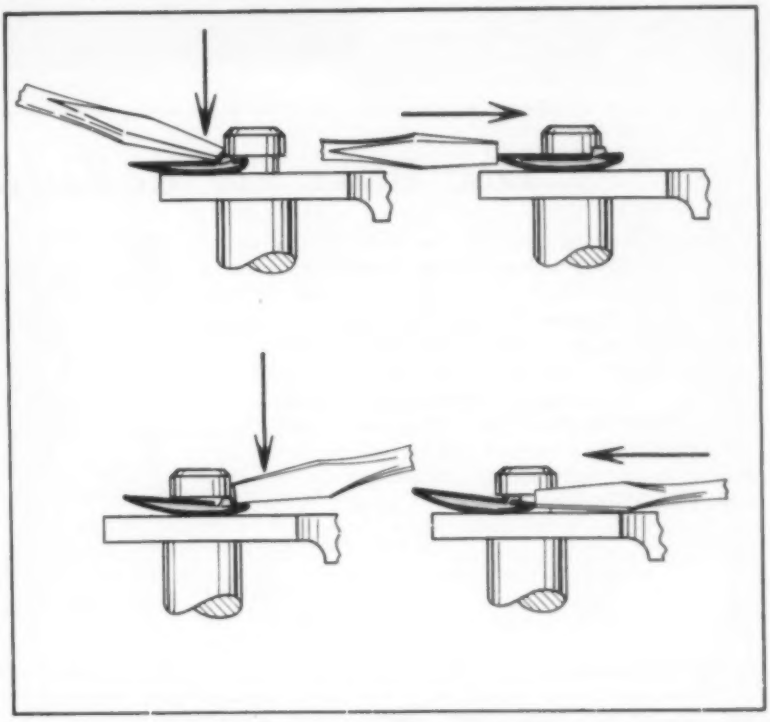
It is because of this positive lock that the new part may be used as a shoulder against rotating parts. Bowed construction provides for end-play take-up in an assembly and makes the tolerances required for the parts being fastened less critical. Because the new washer functions as a spring as well as a shoulder, it is asserted to eliminate certain accessory parts in some designs.

The new fastening ring is mounted on a shaft by placing it next to the shaft and compressing until the locking prongs enter the groove provided. The ring is then pushed forward until its prongs pass the outer diameter of the shaft, at which point the part springs back to its normal bowed shape and is locked into place. Waldes Kohinoor, Inc., 47-16 Anstel P. I., Long Island City 1, N. Y.

For more information—
Circle 2, inside back cover



TOP AND SIDE VIEWS of the new retaining ring—also, the fastening is shown mounted on a shaft. The new fastening is made of spring steel.



TO INSTALL THE RING it is placed next to the shaft and with an ordinary screw driver is compressed until the locking prongs enter the groove. Ring is then pushed forward in the groove until the prongs pass the outer diameter of the shaft, at which time the ring springs back to its normal bowed position and the prongs lock around the shaft. To remove the fastening, screw driver is placed in contact in front of the locking prongs and the ring is pushed down until the prongs enter the groove. The ring is then pushed out of the groove and off the shaft. This fastening device is said to be positive locking against radial displacement such as that encountered in assemblies like this one.

CONTINUED ON PAGE 218

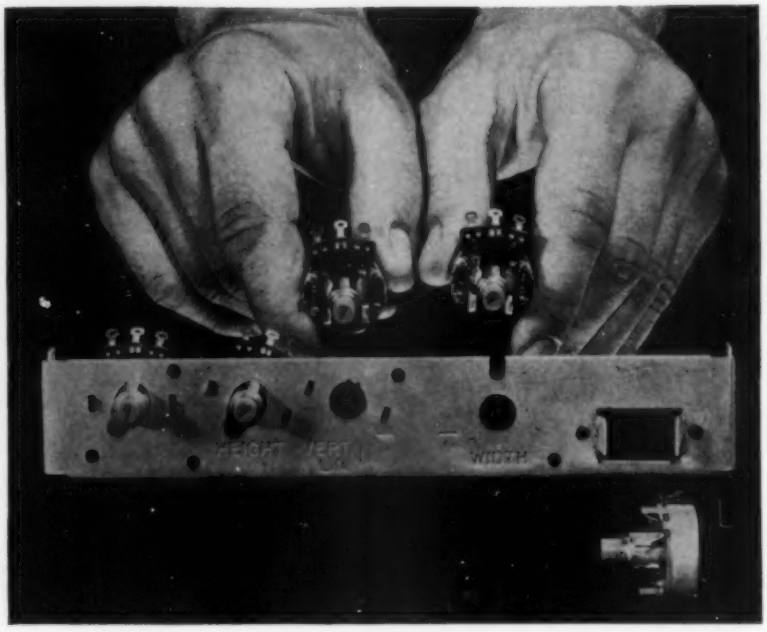
Snap-In Control Simplifies Assembly

Eliminating all mounting hardware, twisting of tabs and mounting tools, this control is simply pushed into the mounting hole, where it snaps into place. Six spring clips grip the panel tightly. Since both hands are left free to insert controls, two can be snapped in place at one time, reportedly cutting assembly time up to 73 percent.

These controls are primarily designed for fine-adjustments applications in television and electronic equipment, the units having a short knurled and slotted shaft for fingertip or screwdriver adjustment.

No panel retooling is required, as the new units will accommodate any standard chassis punched for bushing or twist-tab mounted controls, and are available in any standard resistance and taper. Globe-Union, Inc., 900 E. Keefe Ave., Dept. F18, Milwaukee.

For more information—
Circle 3, inside back cover

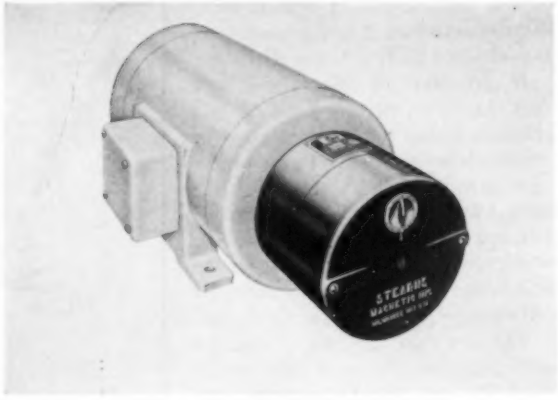


Disc Brake For Re-Rated Motors

These re-designed magnetic disc brakes are for use on re-rated 3 to 20 hp motors, and are available in maximum torque ratings of 10, 15, 25, 35, 50, 70, 75 and 105 ft-lb. The brake is designed for new frame sizes 213 through 286 and is up to $\frac{11}{16}$ in. shorter than previous brakes.

A new feature is the manual release-automatic reset wear indicator. The spring-set, solenoid-released brake is supplied for either horizontal and vertical motor mounting or independent floor mounting and is available with either standard or dust-tight, waterproof enclosure. Stearns, Magnetic, Inc., Milwaukee 46, Wis.

For more information—
Circle 4, inside back cover



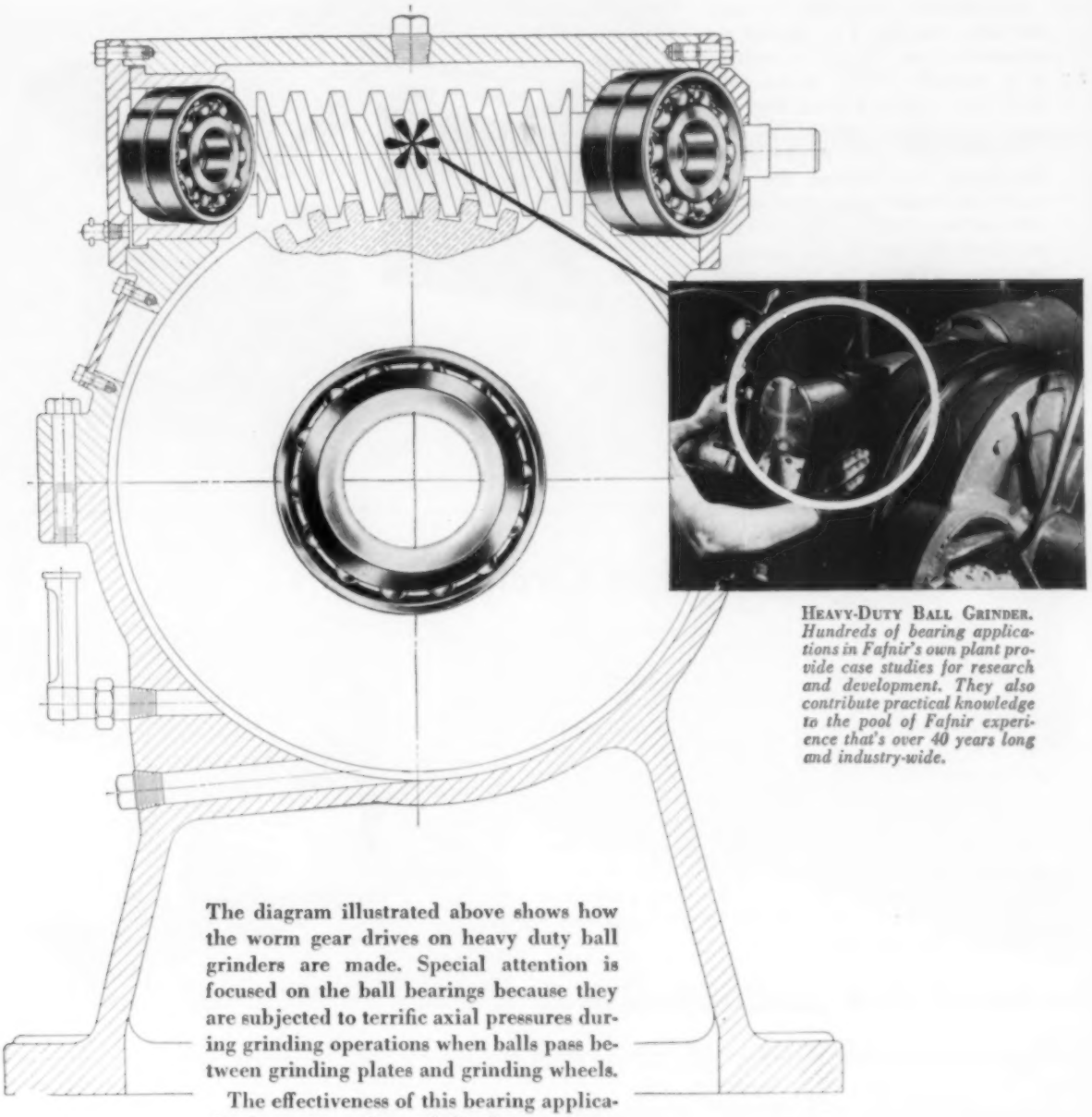
THIS STRAINER, employing a wire mesh basket, is designed for heavy oils and other viscous liquids. It can be used with any liquid that does not affect steel or stainless steel. The strainer is available in nine sizes, ranging in capacity from 6 up to 7050 gpm when handling oil of 100 SSU viscosity. Capacity of any of these strainers varies according to viscosity of the liquid being handled. The flow of liquid may be in either direction through the strainer, but for greatest efficiency the manufacturer recommends from outside-in on the smallest strainer and from inside-out on the larger models. W. W. Nugent & Company, Inc., 410-412 N. Hermitage Avenue, Chicago, Illinois.

For more information—
Circle 5, inside back cover

—CONTINUED ON PAGE 220

More Turns For The Worm

on Fafnir Ball Bearings



HEAVY-DUTY BALL GRINDER. *Hundreds of bearing applications in Fafnir's own plant provide case studies for research and development. They also contribute practical knowledge to the pool of Fafnir experience that's over 40 years long and industry-wide.*

The diagram illustrated above shows how the worm gear drives on heavy duty ball grinders are made. Special attention is focused on the ball bearings because they are subjected to terrific axial pressures during grinding operations when balls pass between grinding plates and grinding wheels.

The effectiveness of this bearing application is a matter of record. On the worm gear shaft illustrated, the duplex pairs of bearings have been in operation for 16 years without replacement . . . protecting the worm gear by rigidly locating its shaft and affording adequate carrying capacity for the combined radial and heavy thrust loads.

If you have similar equipment, maybe we can help extend its service life. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR

BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

Three-Way Control Valve

A moderately priced three-way control valve with full ⅜ in. passage for actuation of air cylinders is available in a "normally closed" model, with hand lever (left) or without the lever hand lever (left) or without.

Requiring but ⅛-in. movement of the plunger for actuation, the valve is said to provide quick response and return of the cylinder. The valve body is drilled for vertical or horizontal mounting. All internal components are brass or aluminum to make the valve completely rust-resistant. Dimensions: 2⅜ in. high, 1¼ in. wide x 2½ in. long, 7½ in. overall (with handle). Air-Mite Devices, Inc., 4417 W. Carroll Ave., Chicago, Ill.

For more information—Circle 6, inside back cover

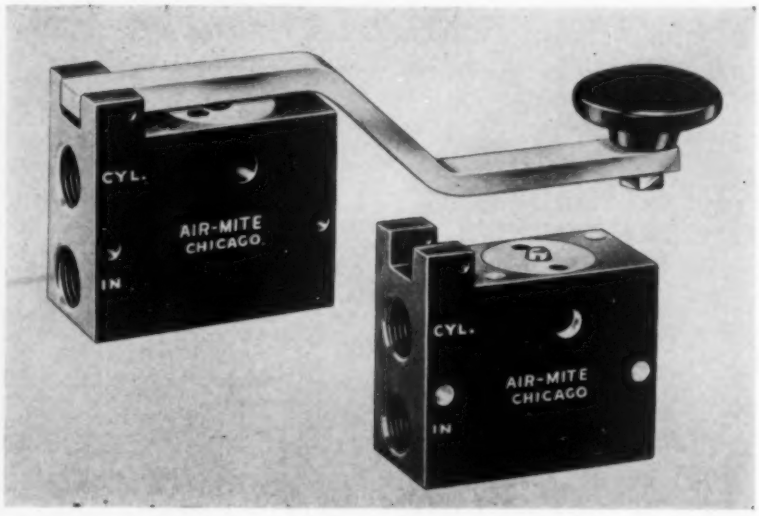


Plate Circuit Relay

Production of a new series of reported low-cost, long-life plate circuit relays has been announced.

This relay is available in coil resistances up to 34,000 ohms with a pull-in rating of 3 ma (approximately 0.09 w). It is equipped with a one-piece back spring and contact arm which can be adjusted. A permanent air armature gap eliminates residual sticking. Contacts are silver, single-pole, double-throw, rated 5 amp (¼ hp) 115-v, ac, non-inductive load. Coil is varnish-impregnated, centrifugally. Base is laminated phenolic, adaptable to screw or rivet mounting. Terminals of this new series of relays are tinned for easy soldering. Dimensions are: 2⅜ in. long x 1 in. wide x 1⅜ in. high, with 2¼ in. mounting centers. Potter & Brumfield, Princeton, Ind.

For more information—Circle 7, inside back cover

A SERIES of "O"-rings for general hydraulics service are molded of "Buna N" fuel and oil resistant compounds. Available in all standard sizes, from ¼ to 16 in. OD, for inclusion in a variety of hydraulic system components. Stillman Rubber Co., 5811 Marilyn Ave., Culver City, Calif.

For more information—Circle 8, inside back cover

ACCORDING TO THE MANUFACTURER, this new relay is designed to give efficient dependable service under extreme conditions of vibration, shock and temperature variations. It is suitable for communications apparatus, aircraft, radar, all types of electronic equipment and other applications, both industrial and military. Available with coils for all standard voltages up to 125v, dc, or 6,500 ohm coil. Average coil consumption, 3 w. Ambient temperature range: −55 to 85 C. Special coils available for relays to be used in ambient temperatures of −65 C to 125 C. Comar Electric Company, 3349 Addison Street, Chicago 18, Illinois.

For more information—Circle 9, inside back cover

CONTINUED ON PAGE 222

Another use of

N·A·X
HIGH-TENSILE STEEL

in modern transportation equipment

Autos are driven aboard the new Evans 6-Car Auto-Loader under their own power. Loading and unloading goes faster—shippers save time and money.

Gives Greater Strength with Lighter Weight to new Evans 6-car Auto-Loader

Evans Products Company, Plymouth, Michigan, chose N-A-X HIGH-TENSILE steel for major parts of its revolutionary new 6-Car Auto-Loader.

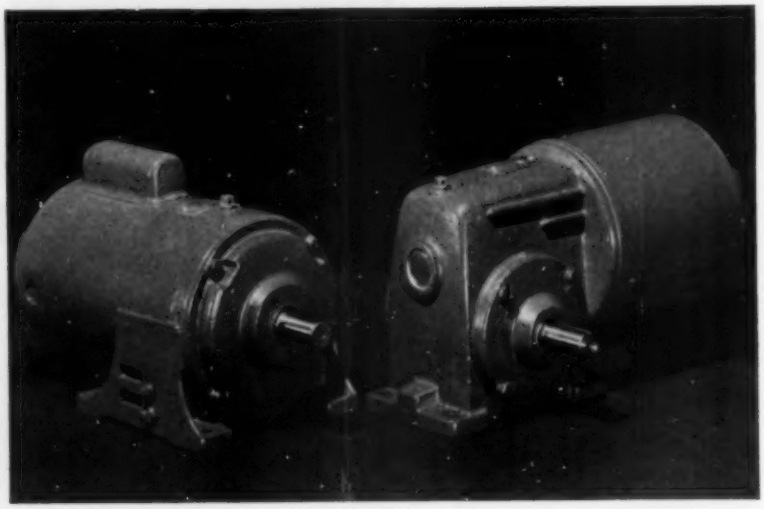
An outgrowth of the original Evans 4-Car loader, this new unit increases pay load by 50 per cent—enables two freight cars to do the work of three.

In designing the 6-Car Auto-Loader, Evans engineers specified N-A-X HIGH-TENSILE steel for all sheet, ramps, shear beams, and vertical members. This low-alloy steel has 50 per cent more strength than mild carbon steel, with greater resistance to corrosion with either painted or unpainted surfaces. In tests carried out at the Evans plant, N-A-X HIGH-TENSILE steel scored high on engineering and impact tests. This new unit was designed with advisory assistance and cooperation from both the A.A.R. Car Construction Committee and the I.C.C.

You, too, can benefit from the many advantages of N-A-X HIGH-TENSILE steel to make your product stronger, lighter in weight, and longer-lasting.

GREAT LAKES STEEL CORPORATION
N-A-X ALLOY DIVISION Ecorse, Detroit 29, Michigan
NATIONAL STEEL CORPORATION

Smaller, Lighter Fhp Gear Motors



Right-angle and concentric-shaft fhp gear-motors that are 10 percent lighter than previous models as well as smaller have been developed for use in products such as machine tools, pumps, printing machinery, conveyors, strip feeders, materials handling equipment. Because the driving motor is close-coupled and positively geared to the output shaft, the new motor units are said to offer the maximum transmission of torque, uniform speed and no slippage.

The motors can be reconnected externally to reverse the direction of shaft rotation. Large bearings, with extra high thrust capacity, are locked to carry motor shaft thrust in either direction.

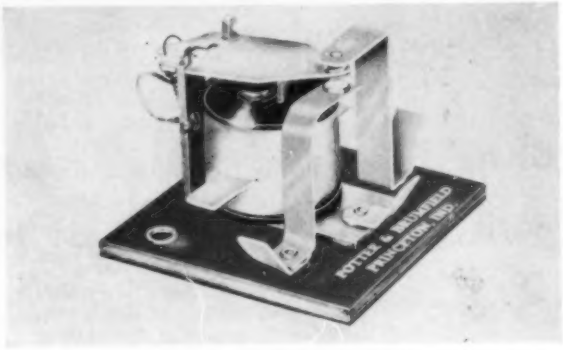
Helical planet gears on the concentric-shaft motor mesh with an integral ring gear, absorbing shock loads. A fixed worm gear on the right-angle shaft motor assures full-rated output with no uneven speeds.

The concentric-shaft motor is available in ratings of $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{3}{4}$ hp, from 13.5 to 520 rpm, 115/230 v single-phase and 220/440 v three-phase. The right-angle shaft gear motor is available in ratings of $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{3}{4}$ hp, from 24 to 148 rpm, 115/230 v single-phase and 220/440 v three-phase. General Electric Co., Schenectady 5, New York.

For more information—
Circle 10, inside back cover

Relay for Household Appliances

Designed primarily for household appliances such as dishwashers, automatic washing machines and refrigerators, this relay is available with varnish-impregnated, a-c or d-c, current or voltage-actuated coils. Large silver contacts afford substantial wiping action and are rated 5 amp ($\frac{3}{4}$ hp), 115 v, ac, non-inductive load. Heavy copper shading ring prevents chatter and hum. Relay is mounted on laminated bakelite base. Relay uses clip-on solder or screw terminals. Mounts with rivets or screws. Dimensions are 2x 2 x $1\frac{1}{2}$ in. high; the relay's mounting holes are on $1\frac{5}{8}$ in. centers. Potter & Brumfield, Princeton, Ind.



For more information—Circle 11, inside back cover

THIS BELTING is for equipment such as sewing machines, shoe machines, business machines, printing equipment. It stretches less than round leather belting and is said to resist slippage, oil and heat. In addition, the improved fabric-and-neoprene construction resists hook pull-out due to unexpected excessive loads. The belt is completely molded, instead of simply being cut out of large slabs of belting material. This insures uniform cross section and eliminates cutting inaccuracies. Splicing of the new belting is easily done with the application of wire belt hooks. Boston Woven Hose and Rubber Company, Post Office Box 1071, Boston 3, Massachusetts.

For more information—
Circle 12, inside back cover

CONTINUED ON PAGE 224

the new sealed GUIDEROL® BEARING BY McGILL

Without Increasing Overall Bearing Size this new SG series provides a single and double sealed bearing unit using a standard GUIDEROL bearing and built in commercial lip type seals. This new GUIDEROL bearing unit advantageously replaces ordinary needle type bearings requiring costly auxiliary sealing arrangements.

Installations are simplified and require less bearing space with corresponding savings in machining costs. Housings can be smaller and less complicated for bearings with shaft sizes ranging from ⅜" to 2".

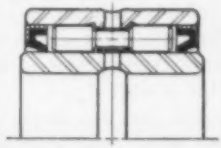
Five different seal combinations provide versatility in handling sealing problems where the proven performance of GUIDEROL bearings can add capacity, dependability and longer life. Using the new complete unit eliminates the bother of separate bearing and seal sources.

Write today for the details on the first sealed unit that offers life-time lubrication for full-type roller bearings.

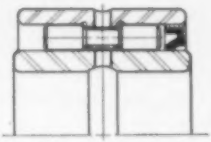
Write today for Bulletin SGR-54 on dimensions, shaft and housing fits and tolerances.

McGill Manufacturing Co., Inc.
201 N. Lafayette Street,
Valparaiso, Indiana

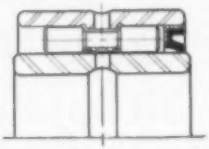
McGILL offers New Sealed GUIDEROL® bearing in 5 seal combinations.



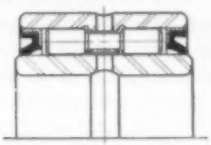
SS—Double seal, lips in. For lifetime retention of lubricant.



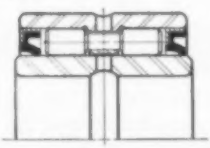
S—Single seal, lip in. Retain lubricant. Usually another sealed bearing at other end of shaft.



RS—Single seal, lip out. Used opposite another bearing to prevent entry of foreign material from one face.



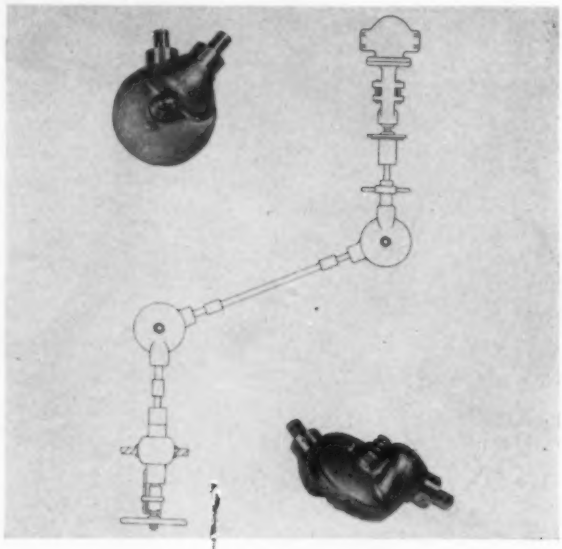
RSS—Double seal, lips out. Prevents entry of foreign materials from both faces.



SRS—Double seal, one lip in, one lip out. For easy relubricating without displacing seal.

McGILL®
precision bearings

Transmits Torque Around A Corner

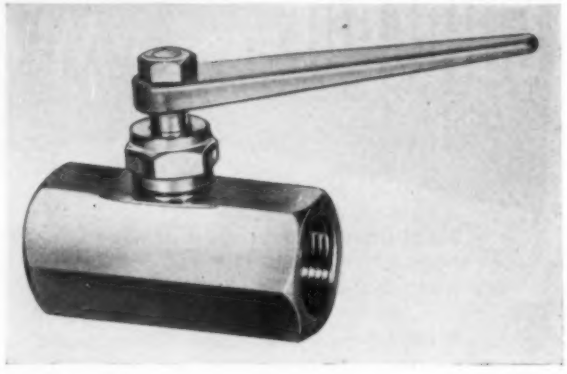


This geared joint makes it possible to control equipment such as valves in spite of intervening obstacles. Manual or motor power is carried around bends by means of bevel gearing at the joints.

It is asserted that this device will operate at angles up to 360 deg. Setting the joint for whatever angle is required is simply done during installation. Three different models of this geared joint are being made, for use with flexible shafts ½ to 1⅝ in. dia and rigid rods ½ to 1½ in. dia. Maximum recommended operating torque ranges, depending on the model chosen, up to 3,500 in. lb. Setting the joints for the angle desired requires no special skill. Stow Mfg., 426 State St., Binghamton, N. Y.

For more information—Circle 13, inside back cover

Double-Seal Ball Valve



Valves based on the double-seal ball principle are being made in aluminum, brass, bronze, Monel, stainless, carbon steel and other wrought alloys, with seats and packings in a variety of plastics. Positive shut-off is maintained under vacuum and under extreme abrasive and corrosive service conditions at 300 and 600 psi working pressures.

Valve opening and closure is effected through a one-quarter turn of lever handle. Valve stem may be removed for repacking while the valve remains in the line, eliminating costly shutdown time. Immediate delivery is promised in all sizes from ¼ to 2 in., inclusive. Jamesbury Corp., 15 Union St., Worcester 8, Mass.

For more information—Circle 14, inside back cover

Armored Hose for High Heat

A rubber hose that is said to have survived more than 270 heats of an open hearth steel furnace is armored with wire for strength and protected by asbestos.

Attached to the hollow steel doors of steel furnaces, the new hose circulates water inside the doors to keep them from melting under the intense heat. Build-up of slag on hose, a factor which shortens the life of other hose in this service, is reduced by a new method of construction.

Despite the cooling effect of the water, heat generated inside the open hearth furnace's doors often becomes great enough to change the water to scalding steam.

Hose is needed for the unusual furnace door application to permit a flexible connection to the water circulation system so that the doors may be opened to charge the furnaces. A new type of flexible construction used in the new hose permits the use of shorter hose lengths to make these connections. Because of its light weight and flexibility, the new hose may be installed by a one-man crew. It is available in 1, 1¼, 1½ and 2 in. sizes. B. F. Goodrich Company, Akron, Ohio.

For more information—Circle 15, inside back cover

CONTINUED ON PAGE 226

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 10

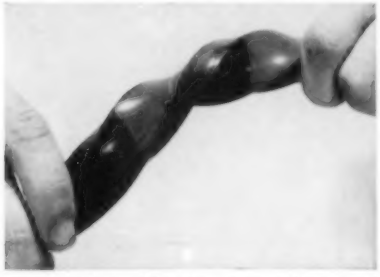
New Silicone Rubber Gum Can Be Sulfur Vulcanized; Blends Give Organic Rubber More Stability

Rubbery parts with properties intermediate between those of silicone rubber and organic rubbers can now be produced by compounding with a new silicone polymer that can be vulcanized with sulfur and blended in any proportion with organic rubbers.

Identified as Dow Corning 410 Gum and available now in commercial quantities, this new polymer can be blended with or applied as a protective coating to extend the serviceable temperature limits and the weather resistance of organic rubbers. Brittle point in the range of —70°F and usefulness at temperatures up to 400°F can be realized by proper blending. The physical properties of the blend will fall between those of high strength silicone rubber and the organic rubber constituent.

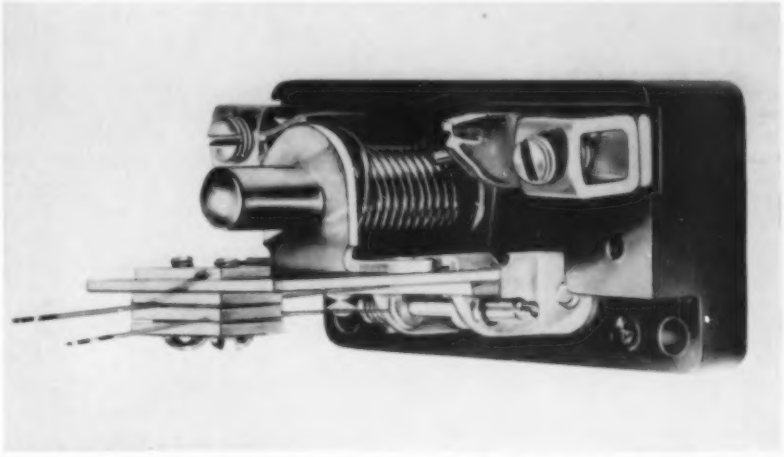
Dow Corning 410 Gum can also be blended with oil resistant rubbers to increase their stability in contact with hot oil. Such blending also markedly improves the ozone and weather resistance of organic rubber.

Tested in an atmosphere created by an ozone generator, for example, a Buna N type rubber, compounded for test purposes, showed failure cracks in less than 30 minutes. Under the same conditions, a fifty-fifty blend of the same organic elastomer and Dow Corning 410 Gum,



compounded with the same fillers and vulcanizer showed no cracks after more than 8 hours.

Priced in the same range as standard silicone rubber gums, Dow Corning 410 Gum is currently available for immediate shipment in commercial quantities. Experimental samples for testing and evaluation are available on request. *No. 94*



DEPENDABILITY OF OVERLOAD RELAY IS ASSURED WITH SILICONE FLUID

Latest addition to the series of silicone-containing Hydraulic-Magnetic Circuit Breakers developed by the Heinemann Electric Company is the Silic-O-Netic type C Overload Relay. A 400-volt service unit, the Type C resets itself immediately when the circuit fault is corrected.

The Type C Relay combines hydraulic and magnetic action. When an overload occurs, a spring-loaded iron core in a non-magnetic tube filled with Dow Corning 200 silicone fluid is actuated by a solenoid coil. The core travels toward the end of the tube to complete a magnetic circuit. Resistance of the silicone fluid slows core travel, providing a time delay inversely proportional to the overload current. Extreme overloads actuate the armature instantly before the core reaches the end of the tube.

Time delay characteristics are determined by core design and fluid viscosity. Of these, the easiest and least costly to vary is the choice of fluid of any particular viscosity. Key to the consistent dependability of the

(Continued pg. 2)

Heat-Stable Silicone Paint Used to Improve and Maintain Appearance of Mercury Engine Manifolds

To preserve a quality appearance in keeping with the automobile itself, the exhaust manifolds and crossover connection of all Mercury automobiles are coated with a heat resistant silicone based paint. Formulated by Midland Industrial Finishes of Waukegan, Ill., the coating stays black and glossy despite surface temperatures in the range of 500 F. Compare that with the burnt-brown appearance of conventional manifolds.

First used on the manifolds of the 1953 Lincoln automobile, the silicone finish is expected to last the life of the automobile. No noticeable deterioration has been observed after as many as 100,000 miles. No additional work is required to apply the silicone paint. It's simply sprayed on the manifolds with conventional production line equipment and baked only 30 minutes at 500 F. *No. 95*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .

SILASTIC RTV—the Dow Corning silicone rubber that's room temperature vulcanizable! Excellent for durable, weather-proof, resilient insulations, encapsulations and seals for electronic components. *No. 99*

Δ

Use of bare magnet wire coated with new Dow Corning Wire Enamel permits operation of small electric machines and electronic parts at 180 C. Flexibility, scrape hardness and dielectric strength compure favorably with those of the best organic wire enamels. Life expectancy at 180 C is in the range of 50,000 hours compared with 200 hours for wire insulated with conventional enamels. *No. 100*

Δ

Dow Corning 20 Compound and 20 Emulsion are effectively used as release agents for epoxy, melamine, methacrylate, phenolic, and polyester resin moldings. Their properties and methods of application are described in a recently published data sheet. *No. 101*

Δ

Dow Corning 6 Compound, a grease-like nonhardening, rust preventative for ferrous alloy metal parts in delicate mechanisms and fine instruments, provides excellent protection during long time indoor or outdoor storage. *No. 102*

Δ

Dow Corning Antifoam A, recognized as a most effective defoamer for a wide variety of aqueous and nonaqueous systems, is now available from laboratory supply houses in convenient spray bomb dispensers. Combined with a volatile Freon propellent, Antifoam A Spray quickly controls foams in many batch processes. *No. 103*

Δ

A new data sheet describes the properties of parts fabricated of various Silastic stocks and pastes. It includes all of the Silastic stocks now available in commercial quantities and lists typical properties of each. It is a convenient reference guide for the selection and use of silicone rubber parts. *No. 104*

Δ

We have recently revised our listing of the manufacturers of silicone (Class H) insulating components. Designers and builders of electric machines and electronic equipment may want to refer to these Sources of Supply. *No. 105*

Silicone Compound Insulates Geophysical Cable Connections

To prevent salt water and pressures up to 20,000 psi from damaging electric cable connectors, the Schlumberger Well Surveying Corporation of Houston, fills the connecting junctions with Dow Corning S-2452, a heat stable, water repellent silicone compound.

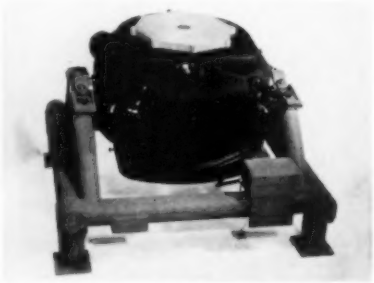
S-2452 is a nonvulcanizing, rubbery paste that remains tacky despite unusually high or low temperatures, moisture or chemicals. Heavier and tackier than regular silicone compounds, it is easily packed into the rubber junction sleeves. It does not harden or wash away in service.

Schlumberger has successfully used Dow Corning S-2452 to insulate cable connections for over three years. During this time no electrical leakage has occurred from properly filled junctions despite direct contact with drilling muds of all viscosities. *No. 96*

Silicone Insulation Protects Shake-Testers Against Overloads; Provides Extra Margin of Reliability

The success of manufacturers producing highly specialized electrical equipment frequently hinges on the trouble free performance of their complex and unfamiliar units. That's why more and more of these manufacturers are building silicone (Class H) insulation into their products.

Take the Calidyne Co. of Winchester, Mass., for example. For six years Calidyne has been manufacturing a line of electro-dynamic "shakers" used to determine the vibration resistance of various assemblies, machines and equipment.



Units to be tested are fastened to a shaker table which is then connected to the armature coil. Vibratory motion is achieved and controlled by the simultaneous passage of an AC current through the armature coil and field of the electromagnet.

No Calidyne shaker has ever been reported burned out, although some are occasionally operated for days at top load. Built in blowers keep the coils cool enough when operated under standard loads. But it's Class H insulation made with Dow Corning Silicones that provides the necessary protection against accidental overloads. *No. 97*

OVERLOAD RELAY ASSURED *(Continued)*

time delay is the fact that the chosen viscosity remains constant, even after millions of operations in service.

Unlike organic oils, Dow Corning 200 Fluid retains a relatively constant viscosity over a wide temperature range; it does not thicken or thin out. This important feature plus high resistance to oxidation and gumming helps keep the relay's actuation point unaffected by variations in the ambient temperature.

These same properties are utilized in another type Heinemann relay which is pre-set at the factory for delay intervals of from 1 second to 2 minutes. The delay interval is determined almost entirely by the viscosity of the Dow Corning 200 Fluid that is selected. In all these relays hermetic sealing is used to assure cleanliness and freedom from tampering. *No. 98*

Dow Corning Corporation, Dept. RI-22, Midland, Michigan

Please send me: 94 95 96 97 98 99 100 101 102 103 104 105

NAME _____

TITLE _____

COMPANY _____

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SILICONE NEWS is edited for product design and development engineers by

DOW CORNING MIDLAND — *first in silicones* — DOW CORNING SILICONES — CORPORATION MICHIGAN

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RESULTS OF AN INTELLECTUAL REVOLUTION . . .

"The Western Miracle" Continues . . . More Automatic Controls for Industry

Within recent weeks three new monthly technical magazines devoted to automatic control systems for industrial processes and machinery have offered the public their first issues. One of these is CONTROL ENGINEERING, a McGraw-Hill publication.

What has caused this surge of interest in the design and application of automatic control systems? What does it portend for the future of American industry? More important, what does it promise for the American standard of living, of which industry is and must be the servant? And what is the role of CONTROL ENGINEERING in this development? It is to those questions that this statement is addressed.

A New Intellectual Revolution

It is frequently asserted that we are now in the throes of a new industrial revolution. The revolution is described as the eliminating of wasteful applications of human labor to repetitive tasks through new technology which makes it possible to transfer those tasks to automatically controlled machinery.

It is perhaps more accurate, however, to say that we are the beneficiaries of a new intellectual revolution in the application of science to industry. This new intellectual revolution points the way toward giant strides in the continuing process of taking dull and laborious work off the backs and minds of men and transferring it to machines operating in large batteries under automatic control.

The practical engineering work required to convert this intellectual revolution into a full-scale industrial revolution, however, in large part still remains to be done. It is to this task that CONTROL ENGINEERING will be devoted. Its role is that of bridging the gap, in engineering and economic terms, between the new conceptions of automatic control of industrial processes and their practical workaday application. These conceptions run the full gamut from systems of control for automatic factories making heavy industrial products to highly personalized systems of automatic control to warn people when they are approaching the broiling point in sunning themselves at the beach or becoming too drowsy to drive their cars safely.

Enter the "Feed-Back" System

Enough work has been done to move these conceptions out of the realm of interesting dreams and into the realm of practical possibilities, and in some cases into the realm of practical realities. Crucial parts of this work were done during World War II when weapons were successfully equipped with "feed-back" systems

that automatically corrected mistakes made by the weapons in locating their targets.

The principle of the "feed-back" system is as ancient as the personal monitor that tells us not to run into each other as we walk along the street. It feeds back to our locomotion machinery the warning of a collision ahead. But the application of the principle to weapon control and then to more general machinery control required superlatively imaginative and skillful scientific development.

When a "feed-back" system that monitors an automatic process and keeps it lined up precisely is teamed up with a computing machine, capable of making lightning calculations that control both what goes into the process and what is done with the product, the horizons of automatic control become broad indeed. But in large part they still remain horizons. A vast range of practical engineering work remains to be done to realize anything like the full potential of automatic control of industrial processes and machinery.

More and Better Jobs

There are those who view the surge of interest in automatic control with alarm. They conjure up a situation in which automatic processes will at once expand the ranks of the unemployed and reduce many of those still working in industry to the status of robots or automatons.

A look at the record of the American economy — a record of amazing growth, steadily improving job opportunities and a constantly rising standard of living — demolishes the basis for such fears. The introduction of new and more efficient industrial machinery and processes obviously cannot be accomplished without creating some disturbance for some individuals and some companies. But consistently the longer range effect of such local and temporary disturbance has been more jobs and better jobs for Americans.

It is no accident that, while the proportion of industrial wage earners in our population is virtually the same as it was in 1920, the proportion of professional and salaried workers has doubled. The proportion of unskilled workers, furthermore, has dropped by half. This has been an essential part of a continuing process by which drudgery has been transferred to machines while the workers who formerly did the drudgery have been graduated to jobs calling for greater competence and providing better pay.

Higher Living Standard

A British historian, H. J. Hancock, has referred to this general process as "the Western miracle" — that of providing an ever higher and higher standard of living for more and more Americans. The key element in this miracle has been more and more reliance on power-driven machines to get the day's work done.

In the nature of the extremely complicated apparatus involved, full development of systems which have passed through the "think stage" into the status of practical possibilities will be a time-consuming process. It will also be a very exacting process, calling for a tremendous application of engineering skill and ingenuity. However, the engineers who are concentrating on this difficult, workaday phase of the development of apparatus for automatic control will be inspired by the knowledge that they are making a crucial contribution to technical progress which holds great promise of good for the American people.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C. McGraw

PRESIDENT

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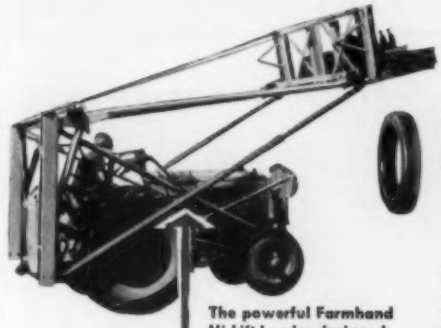
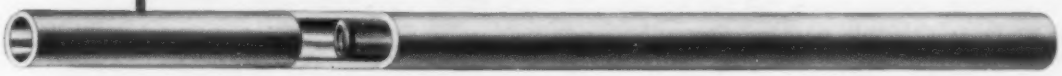


The powerful Farmhand Hi-Lift Loader designed for farm use is also used effectively for industrial loading and lifting. Attaches easily to most tractors.

Problem: To keep a hydraulic seal from being chewed up

Solution: Use Special Smooth ELECTRUNITE Hydraulic Cylinder Tubing



Result: Seals stay smooth

That hydraulic cylinder you're looking at is part of the Farmhand Hi-Lift Loader. It's 10 feet long. It must be free from defects that might affect the functioning of the device—insuring long life for the rubber and fabric cups that seal the hydraulic fluid.

Farmhand formerly made the part out of steel tubing manufactured by another process. Sometimes, interior scratches were detected before assembly. That meant an expensive honing operation or a high rejection ratio which hampered production. If they weren't caught, the rubber cups wore out in a hurry. The customer complained to the dealer. The dealer complained to Farmhand.

The company got together with the Republic salesman and the Republic metallurgist. They discussed the problem, finally came up with an answer: ELECTRUNITE Hydraulic Cylinder Tubing, 3″ x .134″ wall. And here's what they got.

1. Lower cost. Tubing can be used as it's received from Republic with no extra operations.
2. More consistently uniform inside surface finish.
3. Longer life on the cups that act as seals for the hydraulic fluid.
4. Harder surface in a higher Rockwell range than they had in tubing they formerly used.
5. A low ratio of rejections.

This is what we mean by precision tubing. And it's particularly economical in hydraulic applications. If you'd like to know where it fits into your production picture, just call your nearest Republic district office. And do it soon.

REPUBLIC STEEL CORPORATION

Steel and Tubes Division

222 E. 131st Street, Cleveland 8, Ohio

GENERAL OFFICES CLEVELAND 1, OHIO

Export Department: Chrysler Building, New York 17, N. Y.

REPUBLIC ELECTRUNITE TUBING

REPUBLIC STEEL

Other Republic Products include Carbon and Alloy Steels — Titanium — Pipe, Sheets, Strip, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

Speed Reducers for Vertical Shaft Motors

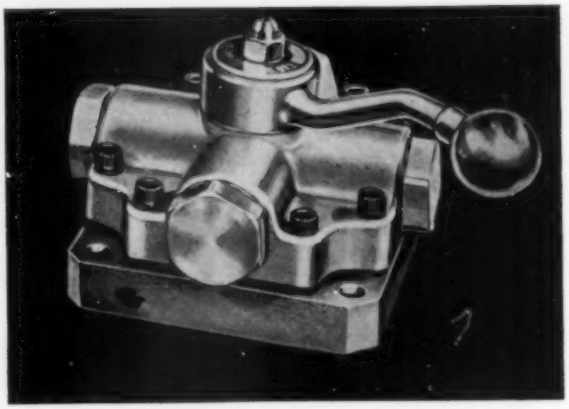
These shaft-mounted units are designed for applications where the driven shaft is in a vertical position or nearly so, such as on mixers, agitators and liquid processing machines. They are available from stock at the factory and at authorized distributor warehouses throughout the United States, and can be supplied in both 13:1 and 20:1 ratios for requirements through 42 hp.

These reducers are said to be equipped with helical gears cut from alloy-steel forgings. Both ball and tapered-roller bearings are used. The unit's three-wall, internally-ribbed cast-iron housing provides permanent gear and bearing alignment, an extra large oil reservoir, as well as a concentric-shaft design.

The units can also be supplied with a torque-arm overload release which gives protection to the driven machine, motor and drive in operations where jam, choke or shock loads may occur. Foote Mineral Co., Exton, Pa.

For more information—Circle 16, inside back cover

Poppet Valve Only 2-in. High



A poppet valve only 2-in. high with rotary handle action has a bottom-ported base and is available in ¼ and ⅜ in. pipe sizes. The valve is a four-way unit and seals with air pressure. Pressure rating is 125 psi. and the maximum recommended operating temperature is 175 F. This valve may be used for higher or lower pressures and for other than air services under special conditions. Ross Operating Valve Co., 120 E. Golden Gate, Detroit 3, Mich.

For more information—Circle 17, inside back cover

Ultrasonic Fluxless Soldering

Ultrasonic soldering equipment has added fluxless soldering to present techniques. It is said to eliminate the need for a thorough washing to remove excess flux and to insure a joint free of contaminates often left by the flux.

The "Sonobond" process will tin aluminum, copper, magnesium and silver. This equipment is being built with sufficient ultrasonic power to tin these metals readily on a production basis, so that it can be used as a regular industrial joining process.

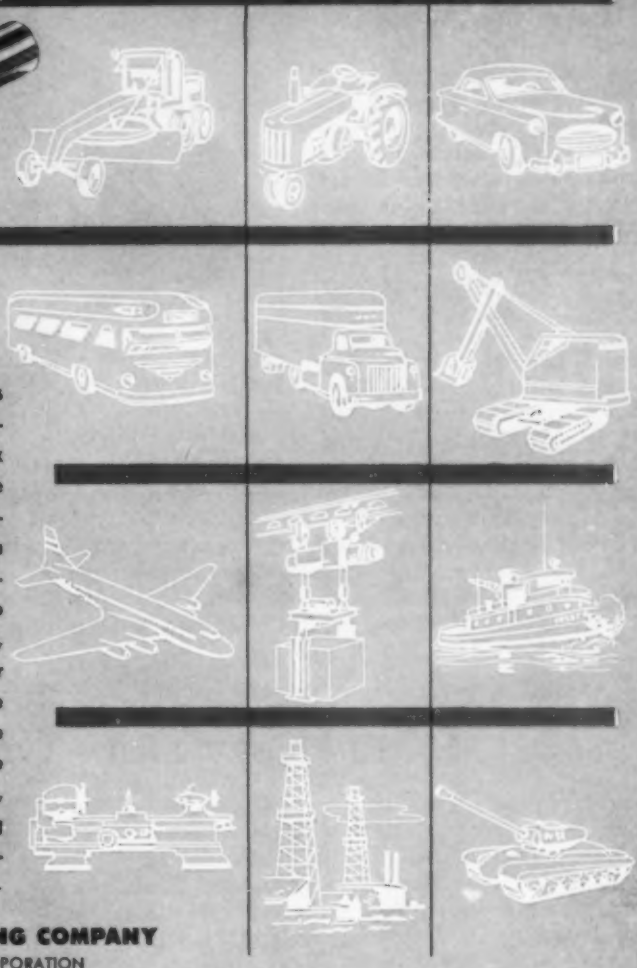
The maker's soldering shop has been using this process for a year and a half on experimental and production orders of 1 to 10,000 parts. In this way companies interested in the new process have been able to determine its usefulness as a production method before the purchase of equipment. The equipment is simple to operate and requires no particular skill on the part of the operator assigned to it. Aeroproducts, Incorporated, West Chester, Pennsylvania.

For more information—Circle 18, inside back cover

CONTINUED ON PAGE 228

EVERY DAY...EVERY WHERE

AETNA BEARINGS HELP EQUIPMENT DO A BETTER JOB



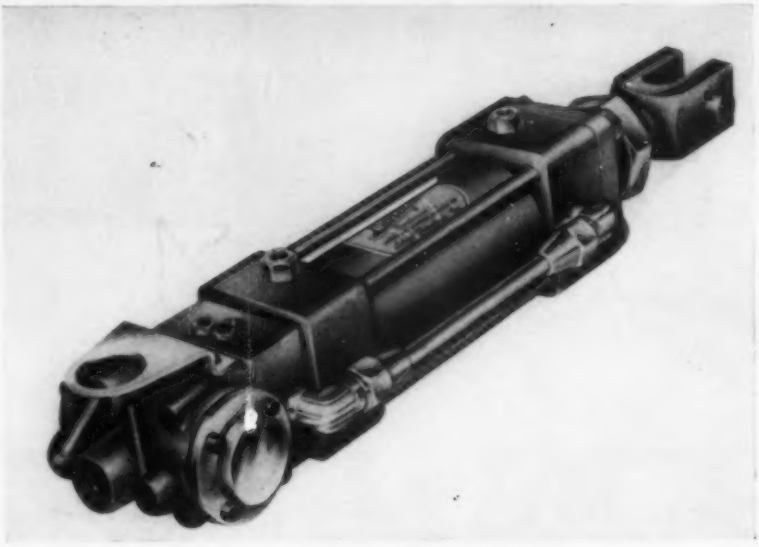
Deep within the equipment that keeps America running are functional assemblies subject to intense vibration, shock loads and constant wear. To provide protection and smooth, trouble-free performance for these assemblies Aetna engineers have teamed with both equipment builders and their suppliers to achieve simplified end product design, higher anti-friction efficiency and lower production and maintenance costs. The results of this cooperative teamwork are written into the success records of the World's finest equipment. Perhaps you, too, can use Aetna's forward-thinking engineering teamwork to good advantage. It costs nothing to find out. Write—

AETNA BALL AND ROLLER BEARING COMPANY
DIVISION OF PARKERSBURG-AETNA CORPORATION
4600 Schubert Avenue • Chicago 39, Illinois

Aetna

MANUFACTURERS OF STANDARD AND SPECIAL BALL BEARINGS, SPECIAL ROLLER BEARINGS AND PRECISION PARTS . . . TO THE MOST EXACTING SPECIFICATIONS . . . FOR EVERY INDUSTRY

Air Motor Has Sealed-In Lubrication



Designed to combine in one compact unit a cylinder, a four-way valve and a wide variety of valve controls, these air motors are now available in bores of 1½, 2 or 3 in. with any desired stroke. Only one air connection is required to bring air to the air motor.

The built-in valve can be operated either manually or by air or electricity. If desired, it can be operated by one of these means in one direction and another of them in the opposite direction.

Air operation is by means of poppet or bleeder valves which control the movement of the four-way slide valve and therefore control the air motor itself.

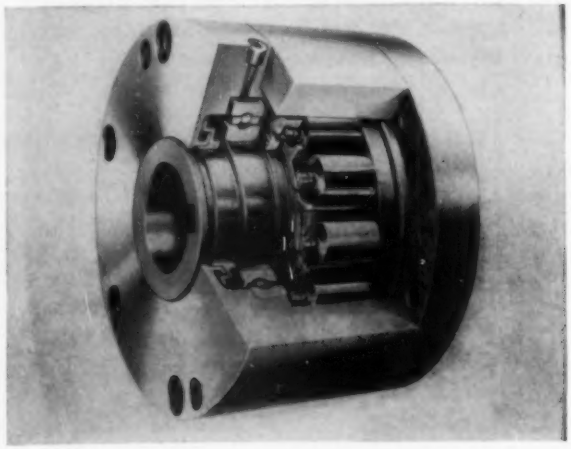
The valve can be operated electrically using any one of these different types of control for the built-in solenoids: (1) Low-voltage, body-ground solenoid 8 to 10 v, operated from the secondary circuit through 110, 220 or 440 v primary circuit transformer which is supplied with this type; (2) 110 v body-ground solenoid type, operating direct without the use of a transformer; (3) 110 v independently grounded solenoids operating direct without the use of transformers. All of these means of electric control operate on a momentary contact type electric switch, having contact of not less than 1/10 sec. Longer contact, however, is not harmful.

The valve body is made of high quality bronze. The valve piston is stainless steel. The slide valve is bearing bronze sliding on a steel bar stock base which assures freedom from grooving.

These air motors can be furnished with or without adjustable cushions at either or both ends of the cylinder. All units have adjustable speed control of the piston rod in both directions. Nine different types of mountings are available. The motors are suitable for air pressure up to 200 psi. Lehigh Foundries, Inc., 1500 Lehigh Drive, Easton, Pa.

For more information—Circle 19, inside back cover

Extra-Heavy Duty Cam Clutches



Extra-heavy duty ball bearing overrunning clutches for indexing, backstop and general duty machinery applications, have a toothed inner race driving member that actuates closely spaced independently sprung cams. These new components are said to be useful for dual drives, two-speed drives, centrifugal water pump drives, forced and induced fan drives and ventilating fan drives.

Tapped holes are provided in both ends of the clutches for attaching sprockets, gears, pulleys or ratchet arms for drive requirements from 1,300 to 6,000 ft-lb. Desired direction of rotation is thus easily obtained by attaching the component to either side of the clutches.

These new clutches are made to fit shafts up to 5 in. dia. Each have made-to-order bores and keyways. Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

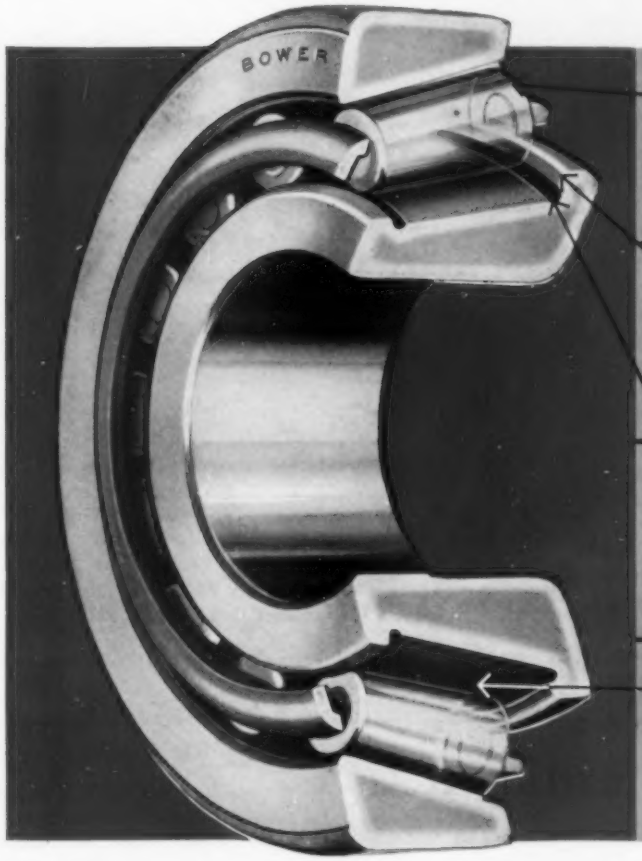
For more information—Circle 20, inside back cover

CONTINUED ON PAGE 230

Here's how BOWER Spher-o-honed design lengthens bearing life... cuts maintenance costs!

The Bower tapered roller bearing design features shown on this page are vitally important to every bearing user. For they illustrate the high quality, precision workmanship and close attention to engineering detail that go into *every* Bower bearing. Even more important, these Bower design features will give you significant bearing advantages such as reduced wear, longer bearing life and lower maintenance requirements. They've been thoroughly *proved* by extensive use in virtually every type of bearing application. If your product uses bearings—whatever it may be—specify Bower now. Or better yet, call in a Bower engineer while your product is still in the blueprint stage.

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN



● **SPHERICAL ROLLER HEADS ARE GENERATED TO THE CONTOUR THEY ACQUIRE IN THE COURSE OF WEAR.** This helps Bower bearings hold adjustment and pre-load longer and better. Normal running-in time is virtually eliminated.

● **HIGHER FLANGE PROVIDES A LARGE, TWO-ZONE CONTACT FOR ROLLER HEADS,** thereby reducing unit pressure. This exclusive Bower feature improves roller alignment, greatly reduces wear and practically eliminates resultant "end play."

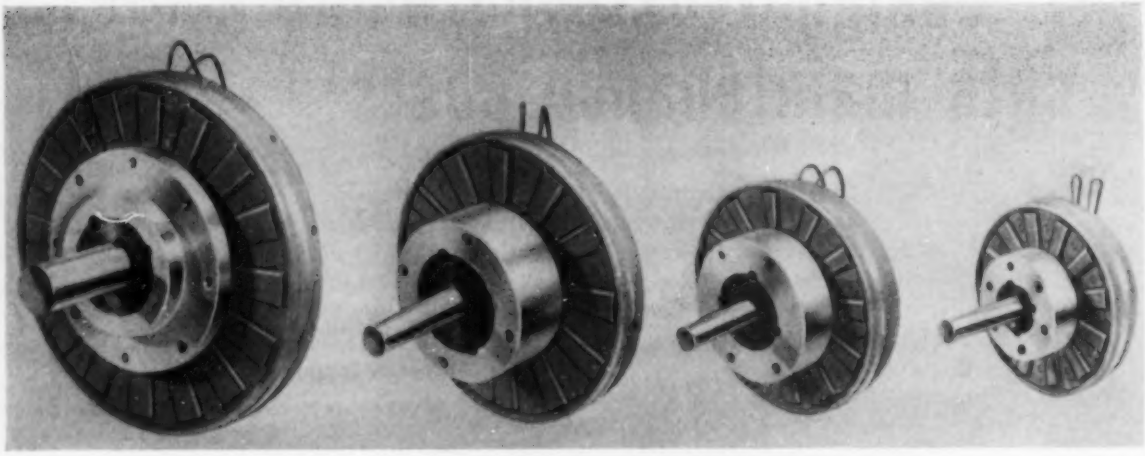
● **LARGER OIL GROOVE GIVES POSITIVE LUBRICATION** at the critical point—where the roller head thrusts itself against the cone flange. Here Bower design provides a larger recess that holds a generous supply of lubricant—increasing efficiency and decreasing wear.

● **PRECISION RACES PROVIDE QUIETER, SMOOTHER OPERATION.** A Bower-developed grinding and honing process provides a micro-smooth surface of hard, crystalline base metal. In this way, close-tolerance precision is built-in to stay! No final adjustment is needed!

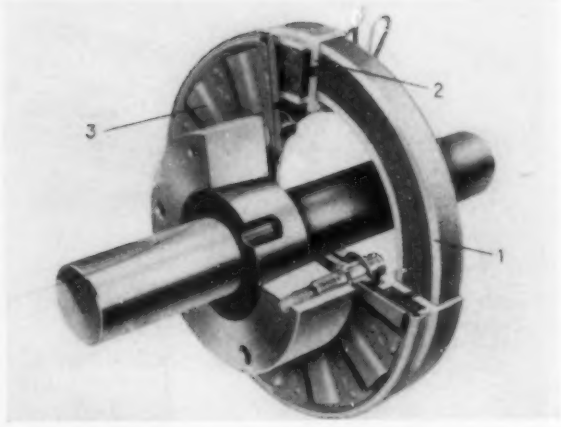
A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS FOR EVERY FIELD OF TRANSPORTATION AND INDUSTRY

BOWER
ROLLER BEARINGS

SPHER-O-HONED



Electric Clutches And Brakes



Electric brakes and clutches suitable for use in all types of industrial machinery are being manufactured in a wide range of sizes, making their application possible on machines which have been unable to use electric control.

The new brakes have a removable facing that is easily replaced. It is similar to the replaceable lining found in automobile brakes. This is said to make it possible for the brake to last as long as any machine on which it is installed, since the only part subject to heavy wear can be changed. The unit has three main parts: the field, the armature, and the replaceable face. The adjustment for wear on the brake is completely automatic and requires no manual servicing, even on machines which operate around the clock.

The electric clutch operates on a "stationary field" principle. This is a new method for inducing current into a rotating coil. The clutch needs no slip rings or brushes.

Both the brake and the clutch can be controlled by a simple push-button, under the control of an operator, or automatically controlled by electric switches, relays, electric eyes or any other automatic system. At the present time both the brakes and the clutches are being manufactured in the torque range of 8 in.-lb to 700 ft-lb. Warner Electric Brake & Clutch Co., Beloit, Wis.

For more information—Circle 21, inside back cover

Motor Starting Relay

This relay was designed specifically for starting single-phase capacitor-start, capacitor-start-capacitor-run fractional or integral-horsepower motors. It can be used to replace the centrifugal switch. It is particularly applicable where adverse atmospheric conditions exist or where it is desired to have remote control incorporated into an explosion-proof case, according to the maker. Most common application for the relay is in the starting of single-phase, hermetically-sealed, refrigerator compressor motors.

Accurately calibrated at the factory to pick up at a predetermined voltage, the relay coil is wired across the starting winding of a single-phase motor. In operation, the relay picks up only when the motor comes up to speed, increasing the induced voltage in the starting windings. The new relay, designated type ARR-1, is available in ratings up to 5 hp, 115/230 v. General Electric, Schenectady, N. Y.

For more information—Circle 22, inside back cover

CONTINUED ON PAGE 232

technical bulletin

EEMCo

a New SLAT ACTUATOR for Jet Fighters

Another linear actuator that performs a special function on latest sonic jet aircraft is this compact new model that was designed, tested and produced by EEMCO for one of the major air frame manufacturers. It is one of many types of EEMCO linear actuators that can be adapted to other uses according to specific needs as to load, length of stroke, rate of travel, or other characteristic. In adapting one of EEMCO's production models much valuable development time and expense can be eliminated.

TYPE D-649 SPECIFICATIONS

Weight: 13.75 lbs. **Stroke:** 3⅜ inches.
Working Load: 3400 lbs. normal tension; 8200 lbs. maximum tension.
Speed of stroke with 3400 lb. load: .55 inches per second on 28 volt DC system.
Maximum Static Load: 18,750 lbs. tension.
Load Limit Switch Actuation: on at 7500 lbs.; off at 9000 lbs.
Flexible Shaft Drive Take-off: non-jamming end stops with retraction stop adjustable within ¼ inch.

Designers and producers of motors, linear and rotary actuators.

Electrical Engineering and Manufacturing Corp.

4612 West Jefferson Boulevard
Los Angeles 16, California

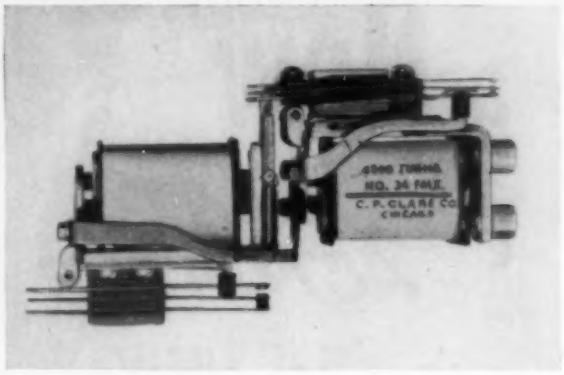
D-634

Electromechanical Latching Relay

This latching relay was designed for the service requirements of business machines, and some of them are said to be still operating at well over 15,000,000 operations.

The assembly shown consists of two Type GAC a-c relays with interlocking armatures. They are aligned one above the other on a common mounting bracket to save chassis space. The assembly may also consist of two Type G d-c relays, or one a-c and d-c relay.

Typical circuit functions performed by this relay include: (1) Hold contacts operated any length of time without consuming power; (2) operate contacts over one lead; release them over another; (3) act as overload relay—electrically reset from remote point when tripped; (4) act as interlocking relay pair on either ac or dc, or combination of both.



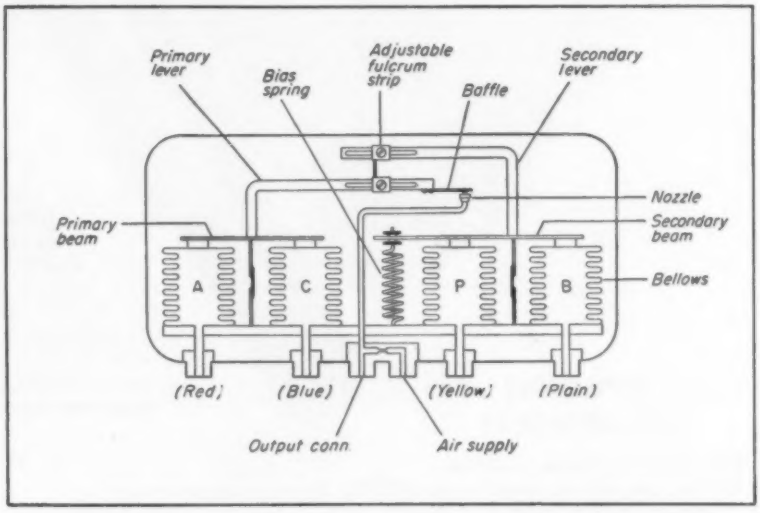
When either relay is energized while the other, deenergized relay is latched up, it will unlatch the other relay, allowing it to restore, and will latch itself up. When either relay is energized while the other is already energized, it will operate its own contacts without latching up, and without affecting the other relay. It will release as soon as its coil circuit is opened. The two relays, however, can be interlocked electrically so that both coils cannot be energized at once. When either relay is deenergized while the other relay is energized, the other relay will become latched up. C. P. Clare & Company, 3101 West Pratt Boulevard, Chicago 45, Illinois.

For more information—Circle 23, inside back cover

Pneumatic Computer Attains 0.005 Percent Accuracy

This instrument is capable of adding, subtracting, averaging and ratioing. It can handle up to three separate pneumatic input pressures with an accuracy of ½ percent. The instrument is intended for processes where two or three different signals must be compared and where variables are required to maintain a constant relationship to each other.

This instrument consists essentially of four receiver bellows, a fixed nozzle and a moveable baffle. For ratioing, a broad range of adjustments from 7:1 to 0.33:1 can be accomplished. Taylor Instrument Co., 95 Ames St., Rochester 1, New York.



For more information—Circle 24, inside back cover

ACCORDING TO THE MANUFACTURER, this speed control incorporates full-wave solenium rectifiers and a special engineered circuit, offering full-rated motor torque with speed ratios in excess of 25:1. It contains no tubes. The unit is available with dynamic braking and instantaneous reverse. It is also available in multiple units. Continuous service life in excess of 100,000 hr is claimed for this new speed control. Erdco Engineering Corporation, Addison, Illinois.

For more information—Circle 25, inside back cover

CONTINUED ON PAGE 234

HERE'S PROOF: You can always count on Continental for every fastener need!

Phillips "Bits—Holders—Screws" are Exclusive with Continental!

...they can cut *your* production costs

Continental is the only manufacturer producing this outstanding Phillips fastening combination—bits, holders, and screws. Their development has finally made power driving really practical, even on finished parts.

They have cut fastening costs as much as 50% and Continental's HY-PRO-Phillips bits average 2 to 4 times longer life than any other . . . one actually drove over 1,000,000 screws. Yes, it's another Continental exclusive in an outstanding record of 50 years in business.

Put your fastening needs in experienced hands. Call direct today or contact your local distributor. Continental can help cut your production costs.

Manufacturers of HOLTITE Fastenings

CONTINENTAL SCREW COMPANY INC. 1904

50th Anniversary

CONTINENTAL SCREW COMPANY

New Bedford, Mass., U. S. A.

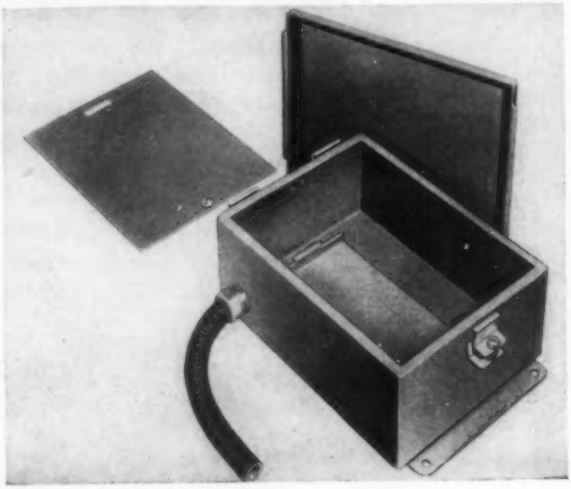
Moisture Trap for Gas, Air, Steam Systems

A float-type moisture trap is now available for air, gas and steam applications. It is designed as a low-cost method of draining moisture and condensate continuously and automatically from piping systems, purifiers and other such equipment. They are suitable for operating pressures up to 200 psi and have an optional inlet for ease of installation.

The trap consists of a stainless steel valve, seat and lever, plus a durable copper hide float inside a cast semi-steel case. A stainless steel float can be furnished when specified. The valve is opened by liquid raising the float and closed when the float drops with the liquid level. These traps are furnished with either ½ or ¾ in. connections, and are tested under working conditions at the factory after assembly. V. D. Anderson Co., 1935 W. 96th Street, Cleveland 2, Ohio.

For more informaton—Circle 26, inside back cover

Watertight Electrical Wiring Box



Manufactured to comply fully with the JIC specification for these boxes, there are no extra holes or knockouts. All conduit holes must be cut in the box.

The cover has a neoprene sponge rubber gasket. The cover is fastened to the box by means of an external hinge and clamp arrangement. There are no screw holes in the cover—no danger of oil leaking into the box if some of the screws are inadvertently left off. The box is mounted or supported by means of external mounting feet. This eliminated the necessity of putting holes for bolts through the box proper.

The box is made of 14 gage sheet steel, the mounting feet of 12 gage. All seams are gas welded. The box opening is flanged for extra strength. It has a removable panel for mounting chassis, timers, relays, terminal strips. The panel is readily assembled into the box by fastening one screw. Hoffman Engineering Corp., Amoka, Minn.

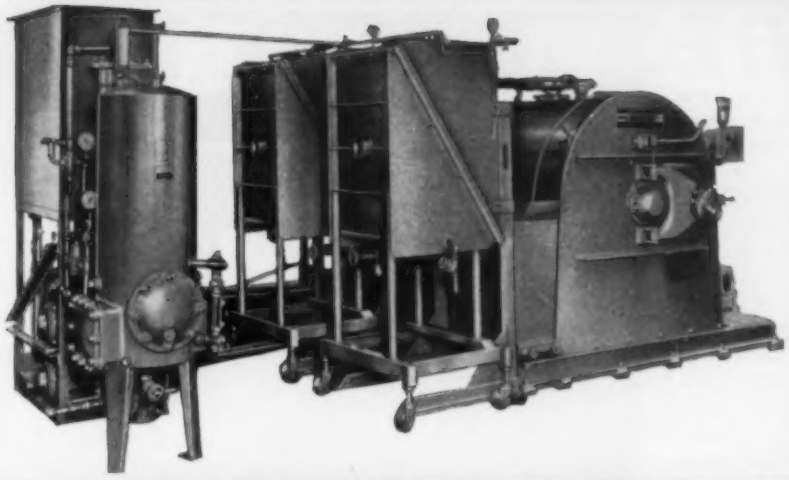
For more information—Circle 27, inside back cover

A LEATHER OIL SEAL that is reported to provide extremely low torque, cool operation, no measurable leakage and exceptional service even at 200 F consists of a chrome-retanned leather sealing lip, coated with a dry lubricant and an elastomer material. The center portion of the sealing member retains the natural porosity of leather, thus permitting the sealing member to absorb and store lubricant for use when the normal supply has been exhausted in service. National Motor Bearing Company, Incorporated, Redwood City, California.

For more information—Circle 28, inside back cover

CONTINUED ON PAGE 236

HOW TO CLEAN WITH SUPER-STRONG SOLUTIONS



Crane Packless Diaphragm Valves . . . find ready application in products of all kinds. Crane design assures long diaphragm life, positive shut-off in case of diaphragm failure, accurate seating, better flow control. They're easy to operate . . . simple to maintain. Specify your choice of body materials, trim materials, and linings. Unlined valves available with screwed or flanged ends. Lined valves, flanged ends only. Sizes up to 6-inch.

another successful product design with piping equipment by CRANE

Bring on your toughest dry cleaning jobs—this specially designed *Trucleen* unit by The American Laundry Machinery Co., of Cincinnati uses soap solutions 5 to 50 times stronger than previously possible. Featuring an automatic two-bath operation, the unit handles 105 pounds of work each 40 minute cycle.

Like many manufacturers, The American Laundry Machinery Co. designed piping dependability into their product by specifying from the familiar Crane Catalog. And it's a time saver, too, containing full information on the world's most complete selection of quality piping . . . with sizes and dimensions, temperature and pressure ratings, plus helpful details on materials and construction.

YOU'LL FIND IT HERE ...IN YOUR CRANE CATALOG

THE BETTER QUALITY... BIGGER VALUE LINE... IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

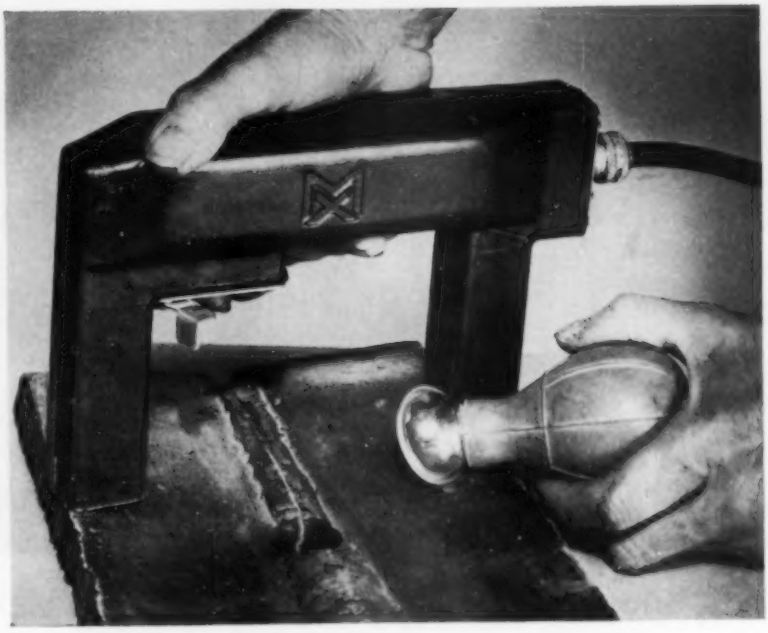
Tool Facilitates Magnetic Inspection

Magnetic inspection of large pieces has been impractical and therefore not specified on drawings in spite of its desirability, especially for inspecting welds. Now magnetic particle inspection can be accomplished with a lightweight, portable and low cost unit. It is designed especially for weld inspection, and for limited volume inspection of any magnetic part wherever surface cracks are suspected.

The Y-5 yoke kit comes in a metal carrying case, about the size of a fishing box, and weighs less than 30 lb.

The area covered by each application of the yoke varies up to approximately 24 sq in., and it is reported that large areas, many parts, or many feet of welds can be inspected per man hour. Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.

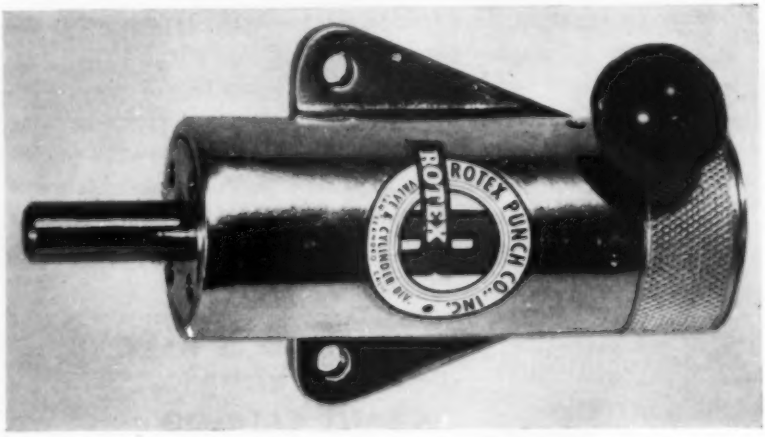
For more information—
Circle 29, inside back cover



Midget Air Cylinder

Consisting of a 1½ in. bore (1:1 ratio) and 1 in. stroke, corrosion-resistant body and a hand-lever valve, this cylinder was expressly designed for jig and fixture work. The manufacturer claims that the elimination of two (out of three) hose lines adds to the versatility of this valve-cylinder combination unit, as it may be readily connected with any air outlet. With a maximum operating pressure of 160 psi, this new midget is expected to replace bulky mechanical clamps. Rotex Punch Co., Inc., San Leandro, Calif.

For more information—
Circle 30, inside back cover



This stainless steel hose clamp is detachable and can therefore be applied quickly to hose which is already in position. The one-piece hardened tightening screw is deep slotted and will accommodate any size screwdriver. No special tool is required. The housing is of a patented, one-piece design, compact and enclosed to permit the proper band width and flexibility for leakproof sealing. These clamps are made to fit hose with ¾ to 2¾ in. and even larger inside diameters. Wittek Mfg. Co., 4305 W. 24th Pl., Chicago 23, Ill.

For more information—
Circle 31, inside back cover

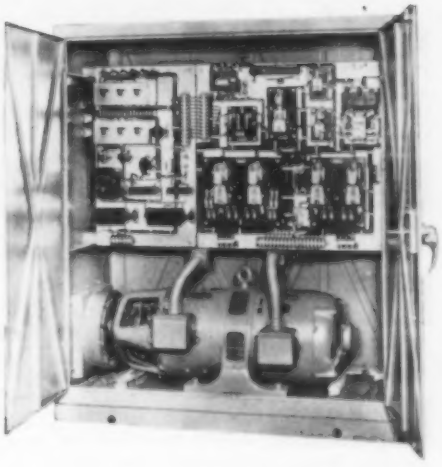
CONTINUED ON PAGE 238

DIAL THE SPEED—CONTROL THE PROCESS

with a Performance Rated® Century SELECTIVE SPEED DRIVE

- **Offers automatic control integrated with your process.**
- **Covers a wide speed range—forward or reverse.**
- **Starts, stops—fast or slow.**
- **Allows forward or reverse jogs.**
- **Controls one or more motors.**

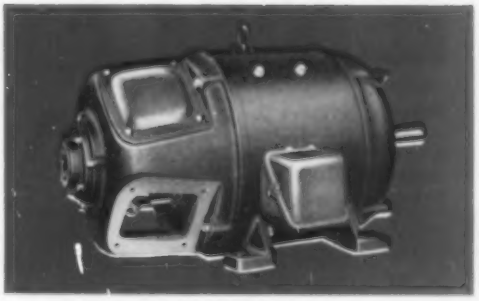
With a Century Performance Rated Selective Speed Drive, you can often integrate speed changes to cycle automatically as the process requirements dictate.



- You can automatically regulate metal cutting for optimum cutting speeds.
- Make the speed change automatically sensitive to changing temperature or pressure.
- Make the speed change automatically sensitive to changing diameter of a feed roll.
- Make the speed change automatically sensitive to the viscosity of a mix.
- You can use many different kinds of control devices in the control circuit to change speeds ... to jog ... to apply dynamic braking, etc.

You're welcome to full information on your specific drive problem. Call your nearest Century District Sales Office or Century Authorized Distributor, or write direct. See telephone listings.

Century makes A. C. and D. C. motors ⅛ to 400 H. P.



Century C Motors

CENTURY ELECTRIC COMPANY
1806 Pine Street, St. Louis 3, Missouri
Offices and Stock Points in Principal Cities

The Ultimate in Labeling

Metal-Cal*

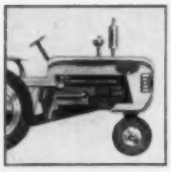
Colorful anodized aluminum for permanent identification

TOUGH

Metal-Cals withstand extreme surface abrasion—are ideal under the most adverse conditions. They are thin, tough, modern nameplates—with no projecting rivets or screws.

HEAT RESISTANT

Metal-Cals meet all government requirements for permanent adhesion in extreme heat and cold. May be used under any conditions, from —62°F. to 300°F.



VERSATILE

Metal-Cals excel for any type of permanent labeling . . . for product identification, wiring diagrams, detailed instructions, component parts and finished assemblies.

Metal-Cals come in a variety of attractive colors—matte or shiny finish—any size or shape.

Metal-Cals apply easily and quickly. Pressure-sensitive adhesive eliminates drilling, screws, rivets, pins or other fasteners.

Metal-Cals assure permanent legibility of the finest lettering or diagrammatic detail.

Write for *FREE SAMPLE*
TEST the advantages of METAL-CAL

Metal-Cal

Manufactured by C & H Supply Co.
415 East Beach Ave., Inglewood 3, Calif.

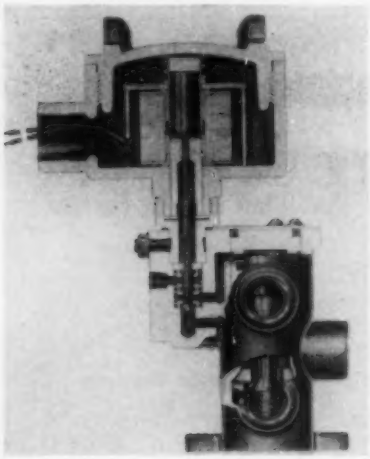
Name_____

Company_____

Address_____

City_____ Zone___ State_____

*T.M. Reg. U.S. Pat. Off.

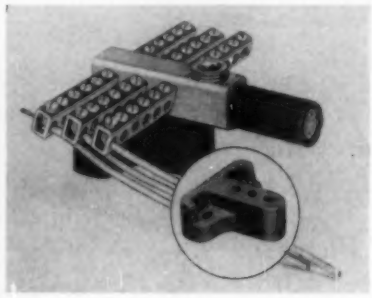


Explosion-Proof Solenoid Air Valves

This valve's extremely short solenoid stroke, with pilot operation, is said to eliminate the problem of coil burnout. Poppet design with a linear sealing contact on resilient seats makes both pilot and main valve self-scavenging. The effectiveness of this design has been borne out in extremely dusty installations like cement batching equipment.

The cover of the explosion-proof housing is removable for quick access to the solenoid; the coils are interchangeable, making it easy to convert to any standard voltage by a simple coil change. Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

For more information—
Circle 32, inside back cover



Forged Neutral Bar

By forging the circuit bars into the main line connectors at a 20 deg angle, wire insertion of every branch circuit into this neutral bar is easier and it is asserted that the unit is stronger and separate connectors are eliminated. The new bar is shown on a plastic block, used for mounting. It is sold with or without this block.

Design of this neutral bar has been kept compact so that they can be used in limited space. Wiring has been simplified because it is not crossed. Connections are made parallel to each other. Better connections also result because there is no spreading of wires away from the setscrew head. The usual washer-head screws are eliminated and there is no forming of wires around and under the screw head.

A larger range of wire sizes can be used. Circuit taps take No. 14-6 and the main line load is 250MCM-6. Outlets are identified and circuits can be traced easily. Extra-hard drawn seamless copper tubing is used in these neutral bars for better conductivity and required maximum strength. Construction has been UL-tested as well as by the Canadian Standards Association. Ilsco Copper Tube and Products, Inc., Mariemont Ave., Cincinnati 27, Ohio.

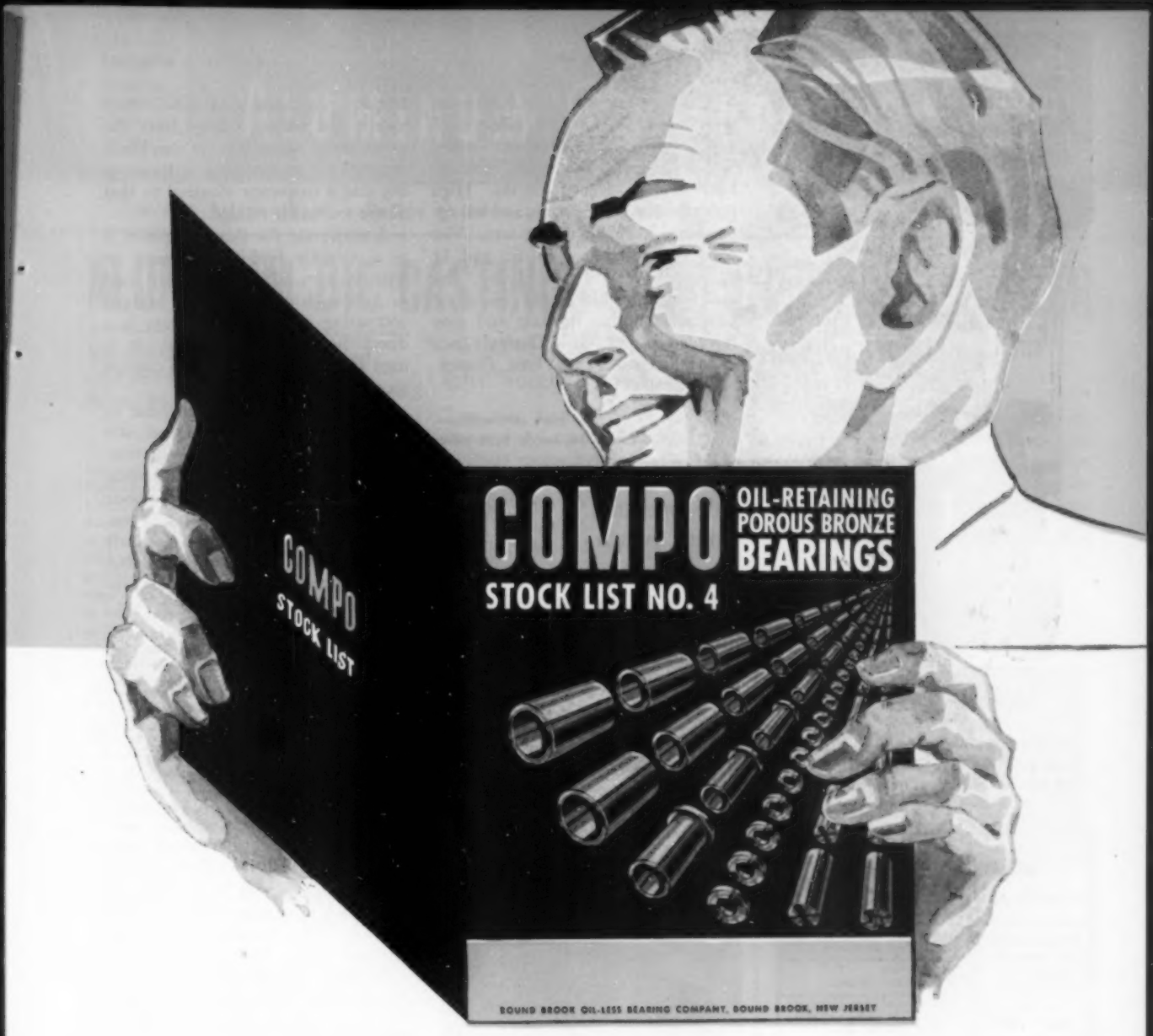
For more information—
Circle 33, inside back cover

Hermetically Sealed Adjustable Thermostat

Electrical thermostats of the C8 Series are actually temperature-operated switches, designed primarily for electronic and aircraft applications and asserted to be suitable for various types of temperature alarm or cut-off service. They are adjustable either at the factory or by the purchaser, by means of an adjusting arm which projects thru the wall of the sealed space. They can be set to operate at any temperature—100 or up to 300 F and they may be exposed to any temperature within this range without change of control point.

Shocks up to 150 G and vibration of 25 G at frequencies up to 1000 cycles per sec do not damage the thermostats or change their operating point. The encasing shell is the temperature-responsive element, providing rapid response since it is in direct contact with the medium controlled. The contact structure and a mechanism to multiply the shell expansion are protected inside the hermetically sealed space.

Factory settings are ordinarily made



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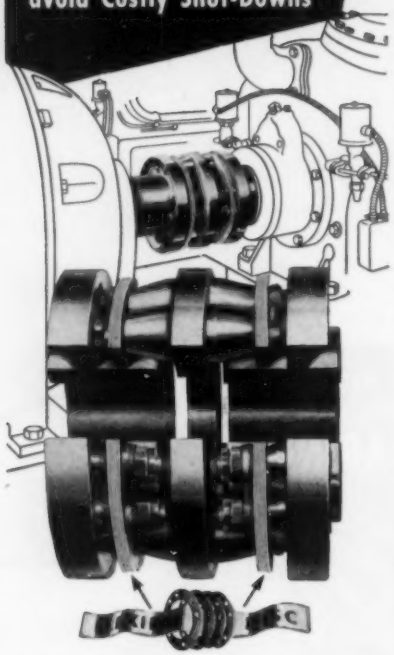
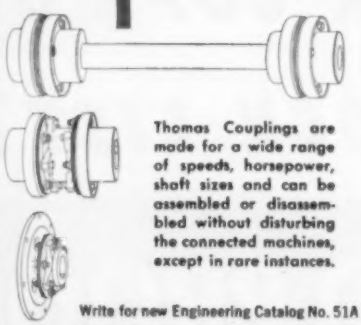
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

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WARREN, PENNSYLVANIA, U.S.A.

to a tolerance of ±1 F and differential is about 1 F. Contact rating is 5 amp at 115 v, ac. Consistent control within ±3 F is feasible with moderate loads in well-designed systems. High potential test is 1250 v, ac, and leakage resistance is 500 megohms min. The basic thermostat is ½ in. dia and 2¾ in. long. Weight is 0.04 lb. The unit is available with mounting flanges, mounting brackets and pipe threaded fittings. G-V Controls Inc., 28 Hollywood Plaza, East Orange, N. J.

For more information—
Circle 34, inside back cover

Side-Operated Safety Switch

A 200-amp safey switch has visible blade construction, ample gutter space on each side for wiring, new patented fuse holder and optional use of solder or crimp-type lugs. The new unit was designed for residential and commercial applications such as lighting and appliance loads. Federal Pacific Electric Co., 50 Paris St., Newark, N. J.

For more information—
Circle 35, inside back cover

A-C Rate Generators And Servo Packages

The rate generator, also known as a "dragcup tachometer" incorporates a specially designed high-purity copper alloy cylindrical dragcup which serves as the rotating element. It rotates in the air gap between a cylindrical stator and a core, both of machined, laminated magnetic steel.

The instrument functions as a two-phase induction generator. When one stator phase is excited by a constant frequency, constant amplitude voltage source, the output voltage from the other stator phase has an amplitude proportional to the speed of the drag-cup and a frequency identical to that of the excitation voltage.

A major use for this instrument is as a velocity feed-back element in servo systems. It has also been used in tachometric applications, and as computing elements where rate is a direct function. In general, it is used anywhere it is desired to convert speed to a-c voltage.

The rate generator is available in four models for 60 cycle and 400 cycle operation, with or without temperature compensation; temperature compensated units operate over a wide environmental range. These rate generators are available in single shaft packages with any of the manufacturer's 10w servo motors. Ford Instrument Co., 31-10 Thomson Ave., Long Island City 1, N. Y.

For more information—
Circle 36, inside back cover

Rigid Plasic Pipe

This piping is reported to be light in weight, odorless, tasteless and non-contaminating and to resist all inorganic acids and alkalis with the exception of a few strong acids. Though satisfactory for petroleum products generally, it has limited resistance to organic solvents. Moisture absorption rate is low. Good strength, rigidity and chemical resistance are maintained over a temperature range of −40 to 170 F.

The new pipe is supplied in sizes from ½ to 2 in. in standard 20-ft lengths, with choice of two wall thicknesses extra-heavy duty (IPS Schedule 80), and standard (IPS Schedule 40). Fittings are also available, with standard IPS threads. Working pressures at 70 deg F for the extra-heavy duty pipe range from 300 psi for the ½ in. pipe to 150 psi for the 2-in. Standard-wall working pressures range from 150 psi for ½ in. to 75 psi for 2-in. Maximum working pressures of thermoplastic pipe are reduced as temperature goes up, and the value for 170 F is about half that at 70 F. These working pressures are based on a safety factor of 5 to 1. This piping is not recommended for temperatures

'54 Forecast: MORE ALUMINUM PRODUCTS THAN EVER BEFORE

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ALUMINUM REPORTER

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★ ★ ★ Fifteenth in a Series to Industry on Aluminum Uses and Developments ★ ★ ★

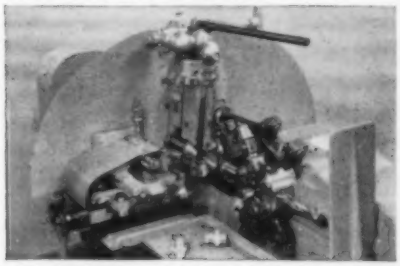
ALUMINUM DIE CASTINGS USED IN POWER MOWER

Reynolds Increased Wire, Rod and Bar Capacity Helps Meet Screw Machine Stock Demand

A new mill which has capacity to produce 36 million pounds of aluminum wire, rod and bar products annually has been completed at Sheffield, Alabama. This new mill, with 130,000 square feet of floor space, almost doubles Reynolds capacity for the production of these products—an important step toward keeping pace with many industry demands including the increased consumption of aluminum screw machine stock which has tripled in tonnage in the past six years. In this connection, it is interesting to note that there are 109,370 multi and single spindle screw machines in the country today.

Reynolds offers a complete line of aluminum screw machine alloys. They are excellent for screw machine work because, job for job, they machine at greater speeds and feeds—with standard tools, or with slight modifications for the higher speeds. You can increase production and cut material, handling and shipping costs with strong, lightweight aluminum that gives you three times the number of pieces per pound.

Rust-free aluminum often requires no finishing but, when needed, takes most of the regular metal finishes . . . also permits a wide choice of attractive anodized finishes in natural tones and sparkling colors.



For prompt delivery on aluminum screw machine stock plus design and fabrication engineering service, call the nearby Reynolds Office or Distributor listed under "Aluminum" in your classified telephone directory. They'll also show you how you can increase your sales and save your customers money if you submit alternate quotations based on aluminum when other materials are specified.

Send for 124-page handbook, "Machining Aluminum Alloys", and index of Reynolds Literature. Free when requested on business letterhead. Write Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

New RPM Lawn-Boy Uses Aluminum Die Castings for Light Weight, Strength, and Production Economies

The new Lawn-Boy Power Mower, made by the RPM Manufacturing Company of Lamar, Missouri, offers an outstanding example of how die cast aluminum parts benefit both manufacturer and consumer. Mower housing, incorporating a 45 cubic inch muffler, engine shroud and wheels are all die cast with Reynolds Aluminum. Die cast aluminum engine parts include starter pulley, flywheel, armature plate, crankcase, reed plate, carburetor, piston, connecting rod and sub base, all shown in the cutaway illustration.

RPM Lawn-Boy Power Mower

"Primarily, aluminum was chosen because it offers excellent durability with considerably less than half the weight of a comparable steel casting," says the RPM Company. "This 18" Lawn-Boy weighs only 37 lbs., but if the same mower were made of steel, it would weigh an estimated 93 lbs., 4 ozs.

"Also, aluminum transmits sound much less readily, thus producing a mower that absorbs rather than amplifies engine noise. From the production standpoint, aluminum is easily cast and lends itself well to difficult contours. It is less expensive both in design and production. It has what production men call 'machineability'. Because of its natural attractiveness and weather resistance, many aluminum parts need not be painted."

Remember—for die castings or any other aluminum parts, the assistance of Reynolds engineering and styling service is available without obligation to help manufacturers make full use of aluminum's many advantages. Consult Reynolds Specialists on your next design or redesign project. Call the Reynolds Office or your nearby Reynolds Distributor listed under "Aluminum" in your classified telephone directory. Or write Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

New Interlocking Ingot Introduced by Reynolds

This unique ingot design—another Reynolds Aluminum first—is more easily palletized, makes stronger bundles that arrive intact and are safer, easier to handle. Bundles can be double or triple stacked to provide shipping and storage economies. In addition, the greater surface area gives quicker melt down. A smoother top surface eliminates chances of trapped moisture and dirt.

For more complete information call the Reynolds Office or Pig and Ingot Distributor listed under "Aluminum" in your classified telephone directory or write direct.

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

(Advertisement)

Printed in U.S.A.

(Continued From Preceding Page)

Aluminum Foil Protects Mainsprings of Watches

Aluminum foil, popular in homes as a protective wrapping material, is finding increasing application in industry. A new use is reported by Hamilton Watch Company, Lancaster, Pennsylvania, who wraps trays of its Dynavar mainsprings in foil before heat-treating.

The Reynolds Wrap is used as a precautionary measure to keep the springs clean until placed in a vacuum furnace, and to protect the springs' bright finish from possible oil or vacuum leaks which might cause discoloration during the four hours they are heat-treated in the furnace.

The watch firm also uses the foil to protect its dies, tool steel parts, and machined components during tempering. Wrapping the parts in Reynolds Wrap before tempering at temperatures below the melting point of the wrap prevents atmospheric discoloration and contamination of the parts. This retains the bright finish of the heat-treated parts and eliminates a cleaning operation which might otherwise be necessary.

For more information on aluminum foil as a protective industrial packaging material, write Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

Reynolds *Do-It-Yourself* Aluminum Used in Plant Maintenance Projects

Reynolds *Do-It-Yourself* Aluminum, a special type of aluminum alloy primarily for home maintenance and improvement projects, is also being used in plant maintenance work.

Reynolds *Do-It-Yourself* Aluminum can be worked without special tools. You can saw it, plane it, joint it, shape it and drill it with standard woodworking hand or power tools.

Reynolds *Do-It-Yourself* Aluminum also has the rustproof qualities, permanence and attractiveness of regular aluminum.

Reynolds *Do-It-Yourself* Aluminum is available in tubing, rods, bars, angles, plain, embossed and perforated sheets, screws and other fasteners.

Chances are, this amazing new material can be put to work in countless maintenance and improvement projects around your plant. For a complete package assortment of Reynolds *Do-It-Yourself* Aluminum, see your hardware supply house. Individual items are available at hardware and building supply dealers. For full details write Reynolds Metals Company, 2576 So. Third Street, Louisville 1, Kentucky.

Press Parts From Reynolds Aluminum Fabricating Service Help Give You the Most From Your Designs

Appliance, automotive, houseware and many other manufacturers in widely diversified industries are relying on Reynolds Aluminum Fabricating Service for the production of aluminum parts ranging from a small aluminum tumbler to a one-piece 12′ by 4′ 8″ aluminum boat hull.

Reynolds A54S Alloy Benefits Tank Industry

An aluminum-magnesium alloy of particular interest to the tank industry is now available from Reynolds Metals Company. This alloy, A54S, is available as sheet and plate in the annealed and intermediate (work hardened) tempers. It has properties between 52S and 56S with mechanical properties somewhat higher than those of 52S and in some tempers comparable to those of 61S-T6.

The excellent corrosion resistance, weldability and strength of A54S make it ideal for tank construction of all types, especially those required to hold pressure. It has been found that the high strength of welded A54S makes possible the use of lighter gauges in the manufacture of pressure vessels, thus reducing material costs. Several tank manufacturers have indicated that material cost reductions effected by going to A54S are in the neighborhood of 20%.

Ammonium nitrate fertilizer tanks, trucks, trailers, tank trailers, ships and other welded assemblies are a few of the places where the A54S alloy offers definite advantages.

For full details call the Reynolds Office or Distributor listed under "Aluminum" in your classified telephone directory. For your free copy of the 130 page handbook, "Aluminum Structural Design," and a complete index of other literature, write on business letterhead. Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

Aluminum Advantages Aid Pulp and Paper Industry

An increasing interest in the use of aluminum in the pulp and paper industry is being shown by mill operators and management because of aluminum's light weight, resistance to corrosive fumes and low maintenance costs.

Aluminum and its alloys are being used in the plants for ventilating ducts, screen covers, walkways, railings, ladders, bus bars, suction boxes, conduit and pipe lines for nitric acid and distilled water. In the woods and logging divisions, aluminum logging chutes and flumes are being used successfully.

There are serious corrosion problems in this industry, not only with the equipment used for the chemical production of pulp but with the metals used in the plant structure. While such members are not in actual contact with the processing liquors they are subjected to the action of chemical fumes, dusts, dirt and moisture. Chemical dusts and dirt deposited on a metal may stimulate corrosive attack because they can retain moisture and some may even become liquid by absorbing moisture from the air. Aluminum's resistance to these contaminants is well known.

In two plants alone, Reynolds offers 128 presses including mechanical presses from 2 to 1700 tons and hydraulic presses from 300 to 5000 tons. Reynolds can furnish press parts from simple blanks to deep drawn parts of large area; from very thin to the thickest aluminum that can be drawn.

Aluminum Pitcher and Tumbler

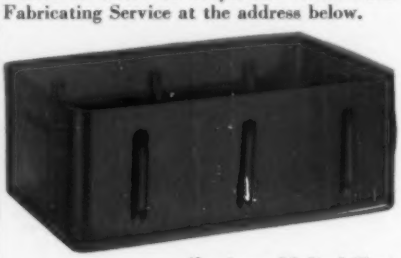
If your designs call for aluminum parts that require blanking, punching, drawing, forming, stamping, piercing, or other press operations, Reynolds Aluminum Fabricating Service can produce these parts to your specifications.

Aluminum Truck Wheel

The great variety of Reynolds specialized equipment permits you to obtain the economy of the machines best suited to your purpose without making the tremendous capital investment in equipment and added plant capacity which would otherwise be required. Reynolds quality control from mine to finished product and Reynolds experienced design and engineering service go hand in hand with these facilities to assure you the most from your designs.

Aluminum Deep Well Cooker

For full details call your nearby Reynolds Office or write to Reynolds Aluminum Fabricating Service at the address below.



Aluminum Medical Chest

A free 24 page "Catalog of Facilities" is available by writing Reynolds Aluminum Fabricating Service, 2065 South Ninth Street, Louisville 1, Kentucky. Other catalogs covering Appliance Parts and Roll Formed Shapes are also free on request.

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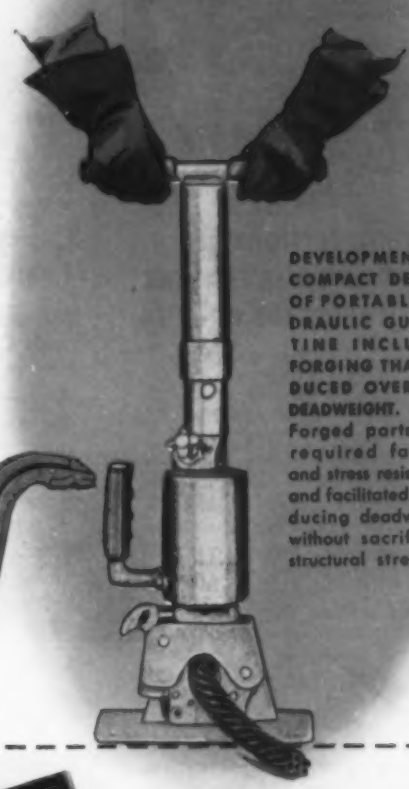
Forgings...

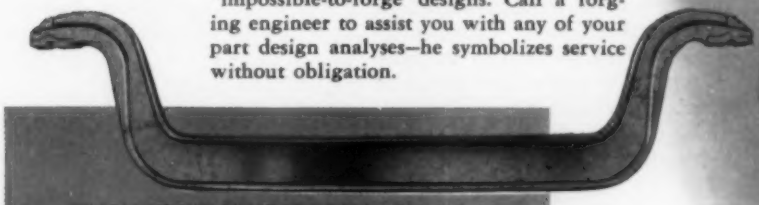
don't need "Deadweight" to make them **TOUGH** *and* **STRONG**

STRENGTH is usually determined from the standpoint of just sheer bulk. The elimination of costly, useless deadweight in closed die forging emphasizes the intensified structural strength and added part durability obtainable by this method of production. Forging compacts the grain structure, kneads the steel fibers into a dense mass of flawless part strength. Metal quality can be developed to the exact degree required to meet a specific service condition.

The process of examining the problem of deadweight can be easily checked with the aid of Problem Parts Charts for Design Engineers, Production Executives, Metallurgists and Purchasing Agents. With these aids and consultation with a forging engineer, you can obtain the correct combination of strength and quality without deadweight as well as the many economic advantages of forgings. The forging engineer can also acquaint you with new cost-reducing techniques for the production of many so-called "impossible-to-forge" designs. Call a forging engineer to assist you with any of your part design analyses—he symbolizes service without obligation.



DEVELOPMENT OF COMPACT DESIGN OF PORTABLE HYDRAULIC GUILLOTINE INCLUDED FORGING THAT REDUCED OVER-ALL DEADWEIGHT. Forged parts met required fatigue and stress resistance and facilitated in reducing deadweight without sacrificing structural strength.



EXCESSIVE WEIGHT NOT NECESSARY FOR A STRONGER PART. This 405 lb. forged I-Beam Equalizer replaced a former 800 lb. unit; saves 395 lbs. of metal, yet is actually a stronger part.

CHANGING TO DROP FORGING, PRODUCT NOW WEIGHS 28 LBS. LESS. Manufacturer of this Plate Grip for handling steel plate obtained the extra benefits of safety and strength without increased cost.

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A New full color 33 min., 16mm. Movie entitled, "Forging in Closed Dies", reveals all aspects of the closed die forging process of forming parts. Represents over ten years of planning and research. It is available for industrial training, sales training, instruction in engineering and metallurgy courses at the college level, and for technical, industrial and engineering societies. Write for information about loan of film without cost.

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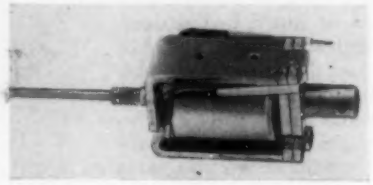
above 170 F, nor for temperatures below −20 F, where physical shock is present. American Hard Rubber Co., 93 Worth St., New York 13, N. Y.

For more information—
Circle 37, inside back cover



Custom Solenoids From 20 Standard Parts

A newly designed line of d-c solenoids said to number 300 types, may now be assembled to order from 20 standard parts. This means exact requirements may be met without sacrificing economy, interchangeability and reasonable delivery. The new design is also asserted to allow simplified changeover to push-or-pull models by adding a threaded ⅜ in. dia. pushrod to any plunger. Joseph Pollak Corp., 81 Freeport St., Boston 22, Mass.

For more information—
Circle 38, inside back cover

Binder for Glass Fiber Mats and Preforms

This acrylic-type water emulsion forms a hard, colorless, thermoset polymer when heated. It can be subjected to 450 F for 5 min without discoloring. Binder P-812 diluted with water can be sprayed conveniently with standard spraying apparatus; a 2 to 6 percent solids solution is recommended. Rohm & Haas Co., Washington Square, Philadelphia 5, Pa.

For more information—
Circle 39, inside back cover

Light-Duty Toggle Clamps

Specially designed to hug the fixture and with a flop-over action which flicks the spindle and holding bar completely away from the working surface, these toggle clamps are proposed for wherever sheets of metal or plastic are to be positioned for light-duty processing. They come in two models, 507-U and 507-S. The 507-U has a U-bar which permits adapting various spindles for proper work contact, especially where there are no welding facilities. Several spindles may easily be mounted in this U-bar.

The 507-S has a solid carbon-steel holding bar instead of the U-bar. They come with a positionable bolt retainer which may be welded to the bar at any desired angle. This model is recommended for holding sheets or strips of metal during welding, drilling and for holding sheets of plastic during laminating, cementing, vacuum-drawing and other similar manufacturing operations. These new holding devices weigh 12 oz and have instant positive holding pressure of 600 lb. Detroit Stamping Co., 350 Midland Ave., Detroit 3, Mich.

For more information—
Circle 40, inside back cover

Flush Latch Prevents Accidental Opening

Flush latches designed for equipment applications such as inspection and access doors employ the "over-center" or toggle action movement to assure positive door closing. Once closed, it is reported, doors can be accidentally opened only by forces strong enough to cause structural damage—yet fingertip pressure only will open the latch. For added convenience, the latch button can be used as a handle for opening and closing. Improved rubber gaskets around the latch opening make the latch splashproof, moisture resistant and dustproof.

Weighing only 1 oz., the device is ruggedly constructed of stainless steel. It has fewer parts than comparable latches. The latch is attached to doors

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an American Welding Specialty

As early as 1949, American Welding was developing production techniques for flash butt-welding of Titanium. Today it produces Titanium rings in addition to a host of other welded components for U. S. airframe and engine manufacturers.

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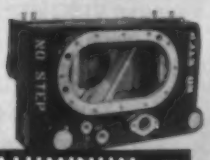
Iron base, heat-resistant alloys such as chromium and nickel chromium steels.

NICKEL

Nickel base alloys, such as Monel* and Inconel*.



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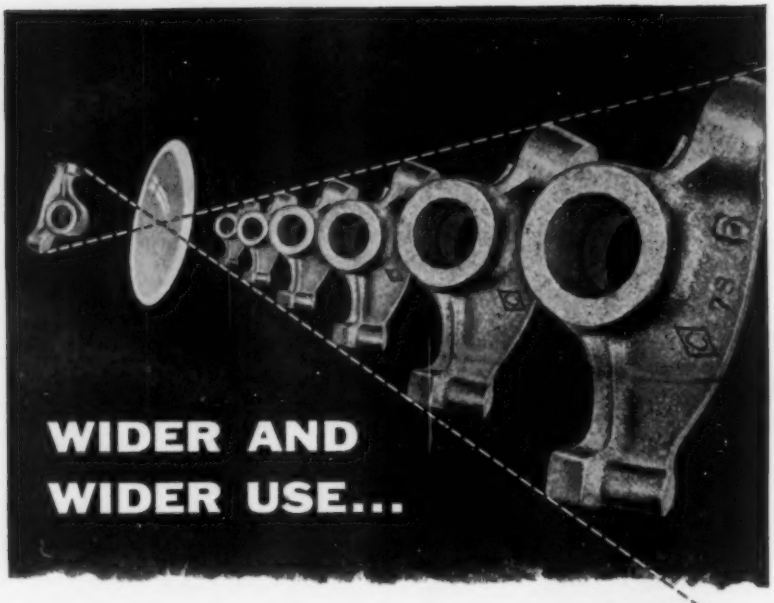
* Registered Trademark International Nickel Company



PEARLITIC MALLEABLE CASTINGS
as engineers see its many advantages

DESIGN ADAPTABILITY: Because of its good fluidity, it can be cast in thin sections and in complicated shapes.

HIGHER STRENGTH: Ultimate strengths range between 60,000 and 90,000 psi; yield strength between 40,000 and 70,000 psi.

EASILY MACHINED: Machinability index (B1112 Steel = 100) ranges between 80 and 90.

WEAR RESISTANCE: Withstands excessive wear under heavy loads at high speeds.

LOCALIZED HARDENING: Sections of the casting can be flame hardened or induction hardened before or after machining.

BEARING PROPERTIES: Good non-seizing properties in metal-to-metal contact.

FINE FINISH: Can be given a very smooth finish where desired.

You will find many applications for Pearlitic Malleable castings – particularly as a replacement for forgings, stampings and weldments – where reduced weight, less machining time, fewer assembly operations and better appearance are important production and sales considerations.

A-9277

NATIONAL MALLEABLE AND STEEL CASTINGS

M&S Co. EST. 1868

COMPANY
Cleveland 6, Ohio

The Nation's largest independent producer of malleable and pearlitic malleable

with four $\frac{1}{8}$-in. dia rivets, and can be installed without special punches or tools. Overall length of the latch is $3\frac{1}{4}$-in. Latches stocked can accommodate a wide range of thicknesses and doors. Modern Aviation Co., 2812 S. Main St., Los Angeles 7, Calif.

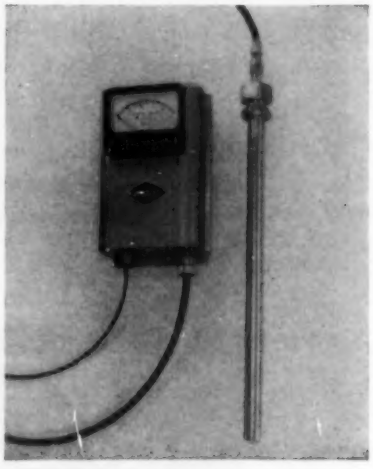
For more information—
Circle 41, inside back cover

Quadrant Orifice Plate

This quadrant orifice has a rounded approach on its upstream face in contrast to the usual sharp edge. This feature makes the orifice insensitive to viscosity changes so long as the throat Reynolds number does not exceed 250,000. Extensive tests indicate that this type of orifice can be used with liquids where the throat Reynolds numbers are as low as 500 and as high as 250,000.

The quadrant type of orifice is recommended primarily to measure flow of fluids whose viscosities vary. In addition, it lends itself to the measurement of small flows. Taylor Instrument Co., 95 Ames St., Rochester 1, N. Y.

For more information—
Circle 42, inside back cover



Capacitive Level Indicator

Suitable for use with most non-adhesive chemicals, milk, oils, refrigerants such as ammonia and the "Freons" and all condensed gases, this level indicator is operable over

Miller HIGH PRESSURE HYDRAULIC CYLINDERS

HARD CHROME PLATED PISTON RODS
Prevent Scratch-Damage, Nicks and Rust

SOLID STEEL HEADS, CAPS and MOUNTINGS
Eliminate Breakage

DIRT WIPER SEALS
Protect Rods, Seals, Bushings

Standard Leather Cup Seal Assembly Shown Is Interchangeable With Miller Standard Piston Ring Piston Assembly

"Stock" Models for Immediate Delivery Added to Famous "Custom-Built" Line

Miller "Custom-Built" Cylinders are available on normal delivery in an *almost infinite selection.*

Identical-quality "Stock" Cylinders are available for *immediate delivery* in these popular sizes . . .

NON-CUSHIONED: 1½", 2½" and 4" bore sizes each available in 2", 4", 6", 8", and 11" strokes. CUSHIONED BOTH ENDS: 2", and 3¼" bore sizes each available in 3", 5", 7", 9", and 13" strokes.

"Stock" Cylinders are basic Model H53 with foot, flange and pivot mounting attachments available as desired.

NOTE: Additional sizes are being added to augment the above list. Stock Air Cylinders also available.

Write For Complete Stock List

WRITE FOR CYLINDER BULLETINS H-104 and A-105

Complete Miller cylinder line includes: air cylinders, 1½" to 20" bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

MET J. I. C. HYDRAULIC STANDARDS years before their adoption in 1949.

SPACE-SAVING SQUARE DESIGN originated by Miller in 1945.

SALES AND SERVICE FROM COAST TO COAST

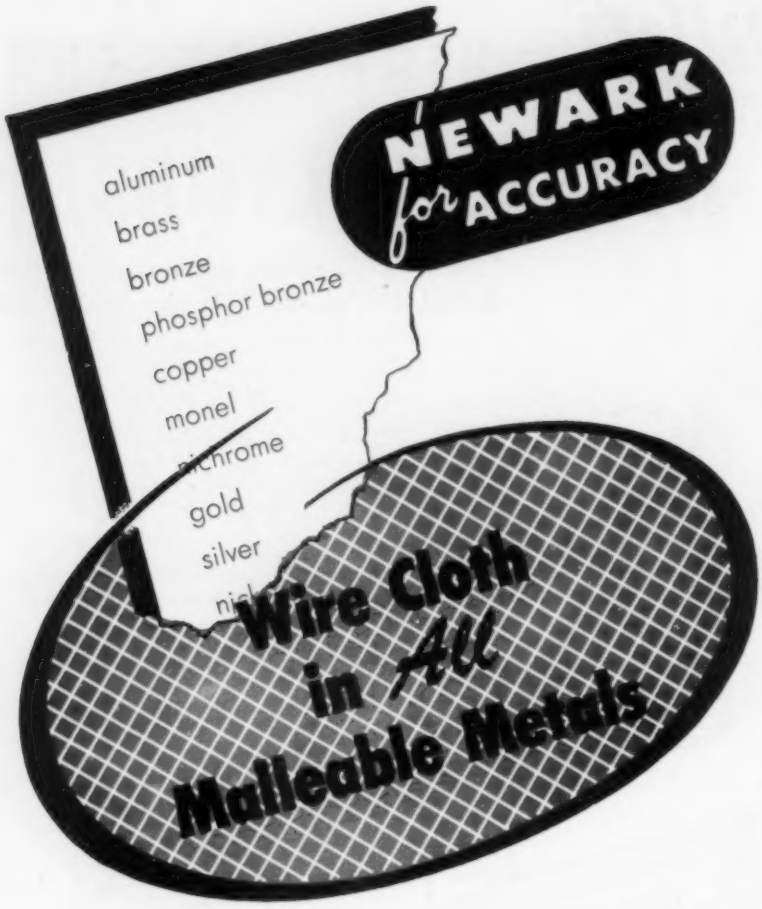
CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

Miller

MILLER FLUID POWER CO.
(Formerly MILLER MOTOR COMPANY)

2002-04 N. Hawthorne Ave., Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS



Newark Wire Cloth is made of *all* malleable metals such as aluminum, brass, bronze, phosphor bronze, copper, monel, Nichrome, nickel and stainless steel; as well as the noble metals such as gold, silver, platinum, etc.

This wide range of metals enables you to select the one wire cloth to meet your conditions of corrosion and/or contamination.

In all metals, Newark Wire Cloth is accurately woven in a wide range of meshes, ranging from very coarse (4 inch space cloth), to extremely fine (up to 400 mesh). Our reputation for 'Accuracy' through more than 75 years is your guarantee of wire cloth quality.

We maintain a large stock of popular sizes in the more commonly used metals and can make prompt shipment. Let us quote on your requirements.

Send for our New Catalog E.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

a temperature range of 500 to -425 F, and from high vacuum to 100,000 psi. It uses a capacitive-type probe with no floating or moving parts or electrodes.

Various probe lengths, materials and designs are available to cover different ranges in the rise and fall of materials, the character of substances encountered and special problems such as the sanitary needs of the food and dairy installations or the non-entraining requirements of relatively viscous materials.

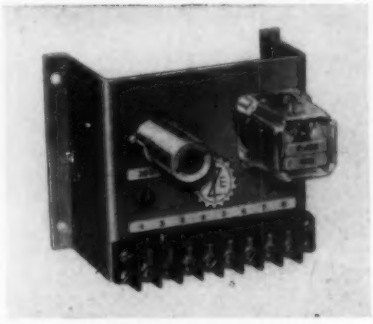
Standard instruments provide for a ten-foot separation between the probe and the equipment housing. However, the interconnecting coaxial cable can, if necessary, be as long as 1,000 ft. Thermo Instruments Co., 1310 County Road, Belmont, Calif.

For more information—
Circle 43, inside back cover

Hydraulic Control Valves

A series of eight new hydraulic control valves have ball detents for position locking. Included are six three-position, four-way valves and two two-position, four- and three-way valves. Logansport Machine Co., Inc., Logansport, Ind.

For more information—
Circle 44, inside back cover



Compact Electronic Relay

This electronic relay is described as having been designed for those applications requiring a compact, inexpensive unit, such as stop-motion devices, gaging and control of various components from contact-making instruments. It will operate dependably with a relatively poor initiating contact, having been called a "contact

amplifier" because it allows the presence of a high resistance in its control or initiating circuit.

Control circuit voltage and current are extremely low, allowing use of delicate contacts with minimum separation. Load contacts are provided for control of external circuits. This allows a means to operate load circuits from delicate mechanisms or contacts, liquids, or extremely light pressures that normally are not capable of performing this function directly. Load contacts are effectively protected to prevent the entry of dust or dirt. Machinery Electrification, Inc., Northboro, Mass.

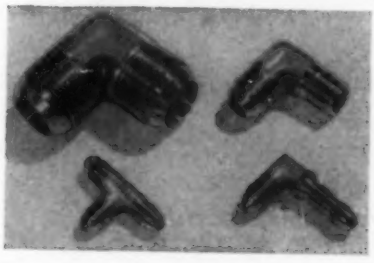
For more information—
Circle 45, inside back cover

Anti-Corrosive Metallic Coating

An anti-rust coating that is said to form a protective shell of aluminum can be used on iron, steel, aluminum or wood surfaces. When brushed or sprayed, a non-porous, anti-corrosive coating is deposited that ethylene glycol or penetrating oil will not seep through, it is reported.

Composed of aluminum in the form of shot, the new coating is bonded to a surface with a patented fluxing vehicle. It dries dust free in less than 1 hr and dries to metallic hardness in 6 hr. Woodhill Chemical Co., 1391 E. 33rd St., Cleveland 14, Ohio.

For more information—
Circle 46, inside back cover



Stainless Steel Fittings

A departure from conventional production of stainless steel fittings is said to be involved in the centrifugal casting method now being used to produce fittings to standard AN specifications or to special requirements

Meet the man who aids design engineers

. . . on bellows assembly design problems

Mr. D. D. Gordon of our engineering staff, specialist in bellows applications.

HE'LL help plan a bellows assembly to answer specific requirements—wherever there's a design problem involving flexible connectors, temperature or pressure control, etc.

He'll recommend the right bellows metal. He'll know the correct bellows charge—volatile liquid or gas. He'll help on these and many more important factors to make your design plans more efficient—your products better.

Sylphon and Bridgeport bellows assemblies are used in many applications—for thermostatic devices, pressure controls, hydraulic mechanisms, expansion joints, as flexible connectors and more uses. Let our bellows application engineers, our half-century of experience and ample production facilities work for you. You'll save time, trouble and money.

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Idea-filled Bulletin gives you the full story about metal bellows and bellows assemblies. Write for your free copy today. Ask for Catalog TP-1400

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION KNOXVILLE 1, TENNESSEE
BRIDGEPORT THERMOSTAT DIVISION BRIDGEPORT 1, CONNECTICUT

while reportedly cutting costs and prices and permitting deliveries on a 30-day-or-less basis. Aside from the time and money factors, the end product itself appears to be of greater strength. In a recent test, hydraulic pressures of 12,000 psi for an 8-hr period are said to have developed no leakage or seepage. Industrial Research Laboratories, 961 E. Slauson Ave., Los Angeles, Calif.

For more information—
Circle 47, inside back cover

Corrosion-Resistant Spring Wire

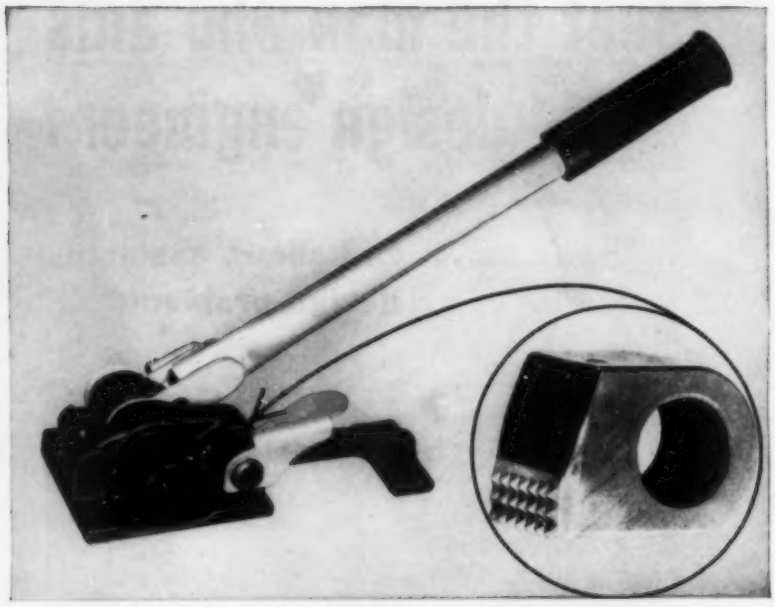
Known as alloy 17-7 Ph, this wire is intended for applications where high spring loadings are required under corrosive conditions, and where compactness of components is essential. Unlike other spring wire, this alloy is said not to lose elasticity under continuous exposure to corrosive atmospheres.

High elasticity is obtained by a combination of cold work before the spring forming operations and heat treatment after forming. This spring is available promptly in a complete range of sizes up to $\frac{1}{8}$ in. National Standard Co., Niles, Mich.

For more information—
Circle 48, inside back cover

Variable Transformer For Low Wattage

Designed for use as a variable a-c voltage component to replace rheostats in electric and electronic equipment, this unit is a toroidally-wound, hydrogen-annealed auto-transformer. It is stated that it will smoothly and continuously deliver any output voltage from 0 to above line voltage. Voltage



Gripping Dogs "BITE" LONGER with Flame-Plated Teeth

Gripping dogs for steel strapping tools are subjected to severe abrasive action and have a relatively short service life. One manufacturer now Flame-Plates this part with a coating of tungsten carbide which provides a hard, wear-resistant surface while retaining the toughness of the base metal. The result: a wear life up to 5 times that of the unplated parts, less repairing and replacing of parts, and more satisfied customers.

Flame-Plating is a new LINDE process for applying wear-resistant coatings of tungsten carbide to the wear surfaces of many parts and tools made of most common metals. For the full story on how you can solve your wear problems with Flame-Plating, read the new "Flame-Plating" booklet.

CLIP COUPON TODAY FOR YOUR FREE COPY

LINDE AIR PRODUCTS COMPANY, Room 308 D
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

Please send me your free booklet on Flame-Plating, Form 8065

Name.....Position.....

Firm.....

Address.....

City.....State.....

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

is adjusted with excellent regulation and no waveform distortion. The device has an extra-long brush spring which allows free action and maintains constant brush pressure during entire brush life. A safety stop on the unit's spring prevents burn-outs by making it impossible for brush-holder to contact the winding when the brush has completely worn down. Type 100BU is rated single phase, 60 cycle, 120 v input-0 to 120 v output, 1.25 output amp, 150/165 va. Standard Electrical Products Co., 2240 E. Third St., Dayton, Ohio.

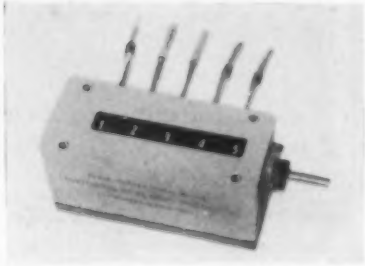
For more information—
Circle 49, inside back cover

Miniature Reverse Pin And Socket Connector

Designed for space-saving side mounting, these connectors are available with 2, 3, and 5 contacts. The precision-machined sockets are of spring temper phosphor bronze, while pin contacts are of brass. Both are gold plated over silver for low contact resistance and easy assembly soldering.

Moldings are available in a choice of three different compounds; mineral-filled "Melamine", "Plaskon" reinforced alkyd type 440, and "Orlon"-filled diallyl phthalate. Dejur Amsco Corp., 45-01 Northern Boulevard, Long Island City, N. Y.

For more information—
Circle 50, inside back cover



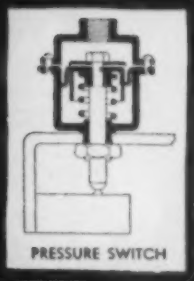
Telemetering Counters

Two series of telemetering counters offered by this equipment manufacturer totalize and visually indicate shaft rotation in either direction in increments of $\frac{1}{8}$ revolution.

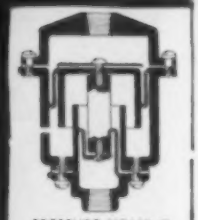
The PC-500 series potentiometer counters have an accurate electrical potentiometer on each counter wheel.

Bellofram*

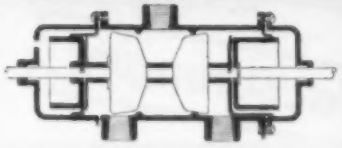
FOR FRICTIONLESS POWER



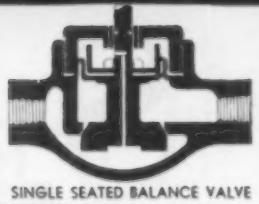
PRESSURE SWITCH



PRESSURE VOLUME TRANSFORMER



BALANCED PLUG VALVE



SINGLE SEATED BALANCE VALVE

IN YOUR FLUID SYSTEMS

When you combine "Bellows" with "Diaphragm" you get "Bellofram." This amazingly simple but new idea in Fluid Barriers performs both bellows and diaphragm functions — easier, better and simpler. A standard Bellofram can be applied to your product.

WHAT THEY ARE

Bellofram seals are long-stroke, deep convolution, constant-area diaphragms with extreme flexing life and exceptionally low spring gradient. They are relatively unaffected by foreign matter, and since they need no lubrication, they are clean. They eliminate leakage. Friction-free, rolling action gives exceptional cycle life. High dielectric strength and remarkable resistance to chemical action are important features. Area accuracy is affected only by surrounding components to which they automatically adapt themselves.

APPLICATIONS UNLIMITED

Bellofram seals may be used in almost any piston-cylinder application, for either precision measurement or frictionless power. Infrequent replacement is the only maintenance. Effective area can be controlled to within less than 0.1% over the working stroke. Efficient operation can be obtained at pressures varying from inches of water to 500 PSIG max. over a wide temperature range. Plan to incorporate Bellofram seals into both your old and new designs. A sketch of your device will help us help you. Strict confidence observed. Write today.

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Bellofram
CORPORATION
144 MOODY ST., WALTHAM, MASS.

FACTS

for fact-hungry

Design Engineers!

WE do not *make* and *sell* gears. We endeavor to "sell" you on our gear engineering know-how and — with your specifications as a base — produce gears which will provide maximum service in accordance with their pre-determined function, operating and environmental conditions and the characteristics of the system of which the gear is a part. Obviously, Perkins' facilities to do all this pre-supposes that our *mechanical equipment* for production matches our abilities in gear engineering. It does!

PERKINS MAKES in all materials, metallic or non-metallic, and in any size, to your specifications: helical gears, bevel gears, sprockets, ratchets, worm gears, spur gears with shaved or ground teeth, ground thread worms.

*Illustrated above: Typical Perkins custom-made gear

NOTE: The PERKINS PRECISION SPRING COILER is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want *when* you want it — in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire Sizes .005 to .125. Diameter from 3/32" to 12" and larger. Size of the compact coiler is only 7½ x 16". **A POWER MODEL** mounted on a welded steel console cabinet base is also available. Full information on request.

PERKINS
MACHINE & GEAR COMPANY
WEST SPRINGFIELD, MASSACHUSETTS

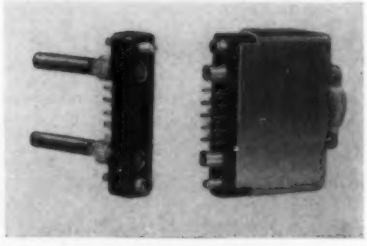
The potentiometer resistance ratios are directly proportional to the visual indication. The CC-500 series contacting counters have electrical contacts corresponding to each number on each wheel. Photocon Research Products, 421 N. Foothill Rd., Pasadena 8, Calif.

For more information—
Circle 51, inside back cover

Asbestos Refrigeration Packing

A compressed asbestos sheet packing for head gaskets on refrigeration compressors is reported to be the first such material to seal "Freon-22" effectively. The new sheet was developed for use in air-conditioning and refrigeration equipment. It has also been proved effective in sealing against all other Freons. The new gasket material meets ASTM 1170-G-1123 and AMS 3231 requirements. It is furnished in standard thicknesses of 1/64 through ⅛ in. and in 11 sheet sizes ranging from 40x40 in. to 150x150 in. Raybestos-Manhattan, Inc., Manheim, Pa.

For more information—
Circle 52, inside back cover



Miniature Connector With Two Coaxial Contacts

A lightweight, compact unit combining 14 conventional miniature contacts and two general purpose RF contacts. The coaxial contacts have a nominal impedance of 53 ohms and minimize electrical discontinuity when used with small cables such as RG-58/U or similar.

All this connector's contacts, both the 14 miniature and the two coaxial, are rated at 5 amp and are gold plated over silver for high conductivity, corrosion-resistance and ease of soldering. Molded melamine, mineral filled, is used as the matrix

NEW AMP PATENTED "F" CRIMP TAPER PINS FOR WIRING AN TYPE CONNECTORS

IMPROVE RELIABILITY SAVE TIME REDUCE COST

Now AN type connectors can be wired 5 to 10 times faster ***with even superior performance reliability.*** There are no cold solder joints, burned insulation, embrittled wire and breakage at solder cups or short circuits due to loose strands and excess solder.

For many years the Aircraft, Electronics and Communication industries have awaited this new and simpler method, since the soldering of wires to conventional AN connector contacts is a slow and painstaking process involving much skill and repeated inspection checks.

With AMP's new Taper Technique, a special AMP Patented "F" Crimp Taper Pin is attached to the wires by high speed automatic machines. This pin is then installed in the connector with one easy and positive stroke of AMP's new "measured energy" CERTI-LOK insertion tool. The result is uniformly better connections, produced in much less time with tremendous cost savings.

Tests prove that AMP Taper Pins provide a greater degree of uniformity than soldered connections. Reliability is actually increased because the possibility of human error in assembly has been greatly reduced.

Leading Connector manufacturers are now supplying AN and other types of multiple contact connectors for use with AMP Taper Pins. Write today for further information.

AMP

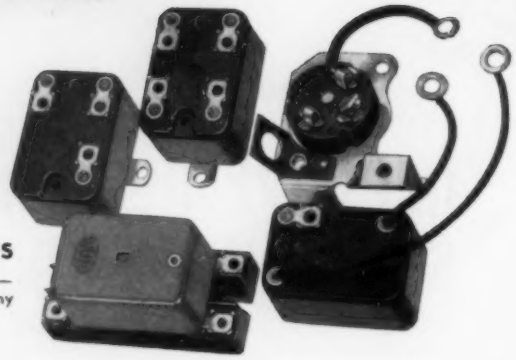
AMP Trade-Mark Reg. U.S. Pat. Off. © AMP

AIRCRAFT-MARINE PRODUCTS, INC.
2100 Paxton Street Harrisburg, Pa.

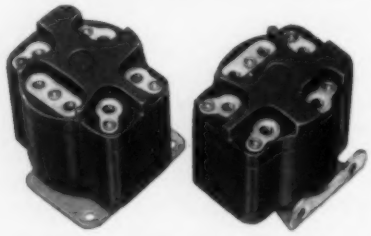
In Canada—AIRCRAFT-MARINE PRODUCTS OF CANADA LTD.
1764 Avenue Road Toronto 12, Ont.

A COMPLETE LINE—
Designed to Your Requirements

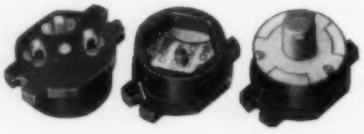
R-B-M
MOTOR STARTING RELAYS AND OVERLOAD PROTECTORS



SERIES RELAYS
Balanced armature—Can be mounted in any position.



POTENTIAL RELAYS
Precision snap-action contacts. Convenient terminal board wiring. Totally enclosed.



OVERLOAD PROTECTORS
Patented bi-metal snap-action—inherent protection. Large solder terminals. Manual and automatic.

Let R-B-M engineering and production facilities serve you. Phone today or write Dept. C-10.

R-B-M DIVISION
ESSEX WIRE CORPORATION
Logansport, Indiana

Controls for Electronic, Refrigeration, Industrial, Appliance, Communication and Automotive Industries

RBM

material. Guide pilots and sockets insure positive polarization.

Voltage breakdown between adjacent miniature contacts is 4000 v, dc, at sea level; 1050 v, dc at 60,000 ft altitude. Voltage breakdown between the inner coaxial contact and ground is 2900 v, dc, at sea level; 700 v, dc at 60,000 ft. Weight of plug, 0.7 oz, weight of receptacle, 0.6 oz. Winchester Electronics, Inc., Dept. K, Norwalk, Conn.

For more information—
Circle 53, inside back cover

Engine Turn Pattern In Metal Sheet

This pattern has a maximum pattern depth of only 0.025 in. yet provides a decorative, prefinished surface that is asserted to resist marring, hide scratches and fingerprints, and reduce glare. It is available in stainless steel, aluminum, carbon steel, brass, copper and all other ferrous and non-ferrous metals. It comes in widths up to 7 in. in sheet, strip or coil, solid or perforated. Rigidized Metals Corp., 673 Ohio St., Buffalo 3, N. Y.

For more information—
Circle 54, inside back cover

Two-Way Packless Solenoid Valves

Two-way solenoid valves may be used for controlling air, gas, water, light oil and other noncorrosive fluids. The valves are available normally closed or normally open, with standard, watertight, or explosion proof solenoid enclosures.

Dimensions of the normally closed valve are 3$\frac{1}{8}$ in. height and 2$\frac{3}{4}$ in.

Where space is limited, specify BCA XLS Bearings

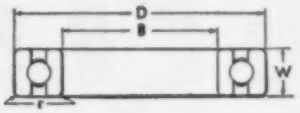
These Conrad type bearings, made to inch boundary specifications, feature a smaller bearing section for a given shaft diameter. This means BCA XLS Bearings are especially useful for applications where space is limited and where weight must be held to a minimum.

BCA XLS Bearings are suitable for any combination of radial and thrust loads. They are used in metal turning machines, earth moving and other equipment.

BCA engineering cooperation and design assistance are available to help solve *your* problems involving ball bearings.

The BCA Engineering Handbook is valued by engineers as an important addition to their technical library. Available to chief engineers without charge. Write on your official stationery.

DIMENSIONS AND IDENTIFICATION



Bearing Number	Bore B	Outside Dia. D	Width W	Fillet Radius* r	Balls		Bearing Numbers	
	Inches	Inches	Inches	Inches	No.	Size	Single Shield	Double Shield
XLS-1⅛	1⅛	2 9/16	9/16	0.047	11	5/16	XLS-1⅛-S	XLS-1⅛-SS
XLS-1¼	1¼	2 11/16	9/16	0.047	12	5/16	XLS-1¼-S	XLS-1¼-SS
XLS-1⅜	1⅜	2 7/8	9/16	0.047	12	11/32	XLS-1⅜-S	XLS-1⅜-SS
XLS-1⅜	1⅜	3	9/16	0.047	12	11/32	XLS-1⅜-S	XLS-1⅜-SS
XLS-1½	1½	3 3/16	5/8	0.047	12	3/8	XLS-1½-S	XLS-1½-SS
XLS-2	2	3 5/16	5/8	0.047	12	3/8	XLS-2-S	XLS-2-SS
XLS-2⅛	2⅛	3 7/16	5/8	0.047	14	5/16	XLS-2⅛-S	XLS-2⅛-SS
XLS-2¼	2¼	3 9/16	5/8	0.047	14	3/8	XLS-2¼-S	XLS-2¼-SS
XLS-2⅜	2⅜	3 ¾	11/16	0.047	14	11/32	XLS-2⅜-S	XLS-2⅜-SS
XLS-2½	2½	3 7/8	11/16	0.047	16	11/32	XLS-2½-S	XLS-2½-SS
XLS-2½	2½	4 1/8	11/16	0.047	16	3/8	XLS-2½-S	XLS-2½-SS
XLS-2¾	2¾	4 1/8	11/16	0.047	16	3/8	XLS-2¾-S	XLS-2¾-SS
XLS-2⅞	2⅞	4 1/4	3/4	0.047	16	3/8	XLS-2⅞-S	XLS-2⅞-SS
XLS-3	3	4 1/2	3/4	0.047	16	3/8	XLS-3-S	XLS-3-SS
XLS-3⅛	3⅛	4 3/4	3/4	0.047	17	3/8	XLS-3⅛-S	XLS-3⅛-SS
XLS-3¼	3¼	4 3/4	3/4	0.047	17	3/8	XLS-3¼-S	XLS-3¼-SS
XLS-3⅜	3⅜	5	3/4	0.047	19	11/32	XLS-3⅜-S	XLS-3⅜-SS
XLS-3½	3½	5	3/4	0.063	19	11/32	XLS-3½-S	XLS-3½-SS
XLS-3⅝	3⅝	5 1/4	3/4	0.063	19	3/8	XLS-3⅝-S	XLS-3⅝-SS
XLS-3¾	3¾	5 1/2	3/4	0.063	19	3/8	XLS-3¾-S	XLS-3¾-SS
XLS-3⅞	3⅞	5 3/8	7/8	0.094	18	7/16	XLS-3⅞-S	XLS-3⅞-SS
XLS-4	4	5 7/8	7/8	0.094	18	7/16	XLS-4-S	XLS-4-SS
XLS-4⅛	4⅛	6	7/8	0.094	19	7/16	XLS-4⅛-S	XLS-4⅛-SS
XLS-4¼	4¼	6	7/8	0.094	19	7/16	XLS-4¼-S	XLS-4¼-SS
XLS-4⅜	4⅜	6 1/4	7/8	0.094	20	7/16	XLS-4⅜-S	XLS-4⅜-SS
XLS-4½	4½	6 1/4	7/8	0.094	20	7/16	XLS-4½-S	XLS-4½-SS
XLS-4⅝	4⅝	6 1/2	7/8	0.094	21	7/16	XLS-4⅝-S	XLS-4⅝-SS
XLS-4¾	4¾	6 1/2	7/8	0.094	21	7/16	XLS-4¾-S	XLS-4¾-SS
XLS-4⅞	4⅞	7	1	0.094	20	1/2	XLS-4⅞-S	XLS-4⅞-SS
XLS-5	5	7	1	0.094	20	1/2	XLS-5-S	XLS-5-SS
XLS-5⅛	5⅛	7 1/4	1	0.094	20	1/2	XLS-5⅛-S	XLS-5⅛-SS
XLS-5¼	5¼	7 1/4	1	0.094	20	1/2	XLS-5¼-S	XLS-5¼-SS
XLS-5⅜	5⅜	7 1/2	1	0.094	22	1/2	XLS-5⅜-S	XLS-5⅜-SS
XLS-5½	5½	7 1/2	1	0.094	22	1/2	XLS-5½-S	XLS-5½-SS
XLS-5⅝	5⅝	7 3/4	1	0.094	22	1/2	XLS-5⅝-S	XLS-5⅝-SS
XLS-5¾	5¾	7 3/4	1	0.094	22	1/2	XLS-5¾-S	XLS-5¾-SS
XLS-5⅞	5⅞	8	1	0.094	23	1/2	XLS-5⅞-S	XLS-5⅞-SS
XLS-6	6	8	1	0.094	23	1/2	XLS-6-S	XLS-6-SS
XLS-6¼	6¼	8 1/2	1 1/16	0.094	22	9/16	XLS-6¼-S	XLS-6¼-SS
XLS-6½	6½	8 3/4	1 1/16	0.094	22	9/16	XLS-6½-S	XLS-6½-SS
XLS-6¾	6¾	9	1 1/16	0.094	23	9/16	XLS-6¾-S	XLS-6¾-SS
XLS-7	7	9 1/4	1 1/4	0.094	21	5/8	XLS-7-S	XLS-7-SS
XLS-7¼	7¼	9 3/4	1 1/4	0.094	22	5/8	XLS-7¼-S	XLS-7¼-SS
XLS-7½	7½	10	1 1/4	0.094	22	5/8	XLS-7½-S	XLS-7½-SS
XLS-7¾	7¾	10 1/16	1 3/8	0.094	21	11/16	XLS-7¾-S	XLS-7¾-SS
XLS-8	8	10 3/4	1 3/8	0.094	22	11/16	XLS-8-S	XLS-8-SS

* Bearing corner radii will clear maximum fillet radius shown.
Note:—These bearings are furnished with pressed steel retainers.

radial, thrust, angular-contact Ball Bearings

BCA

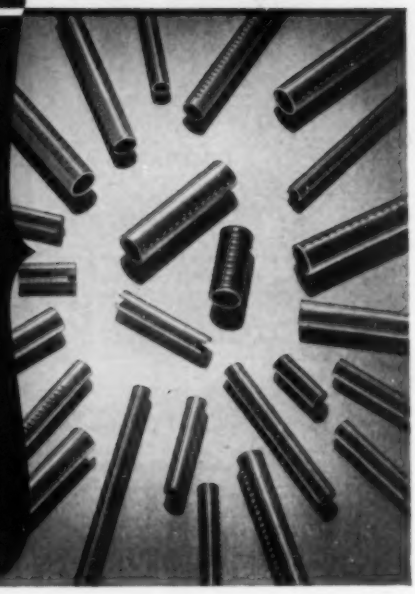
BEARINGS COMPANY OF AMERICA

DIVISION OF FEDERAL-MOGUL CORP.

LANCASTER • PENNSYLVANIA

RESINITE EMBOSSED COIL FORMS

...can increase efficiency of your iron core insertion production by 20%



Special embossed construction eliminates torque control problems and stripping . . . prevents breakage or freezing of cores due to cross threading or improper starts.

Custom fabrication to your exact specification assures correct dimensions to within the most critical tolerances, plus uniformity throughout.

Threads are positioned in accordance with your requirement —full thread, each end, one end, center only.

We will furnish—without charge—a pilot production run of custom-made embossed forms to fit your particular application. We will also send a winding mandrel made to the specifications you supply.

Contact us now for full details about this special offer. Request technical bulletin, *Use of Threaded Tubes, Threaded Iron Cores VS. Torque Control.*

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Syracuse, New York, Syracuse 76-8056

Northern Ohio, Western Pennsylvania:
Cleveland, Ohio, Atlantic 1-1060

Indiana, Southern Ohio:
Logansport, Indiana, Logansport 2555

Missouri, Southern Illinois, Iowa:
St. Louis, Missouri, Sterling 2318

Maryland:
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Division of.. PRECISION PAPER TUBE COMPANY

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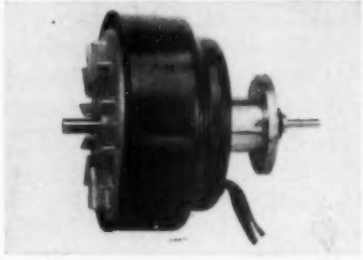
face-to-face. Units for pipe sizes ⅜, ½, ¾ and 1 in. are available. Maximum pressures: 250 psi on air, normally open; 200 psi on air, normally closed. Valves may be used on all standard a-c and d-c voltages. Automatic Switch Co., Orange, N. J.

For more information—
Circle 55, inside back cover

Silicone-Coated Resistors

By using a specially compounded, tough silicone base coating and employing new manufacturing techniques, a line of resistors has been developed that conform to the applicable specifications for vitreous enameled resistors. These new resistors are said to be equal or superior in dielectric strength, insulation resistance, thermal shock and momentary overload. The resistors are wound on steatite cores with silver-soldered connections and are available with lugs or wire leads. Milwaukee Resistor Co., 700 W. Virginia St., Milwaukee 4, Wis.

For more information—
Circle 56, inside back cover



Low and High Speed Synchronous Motors

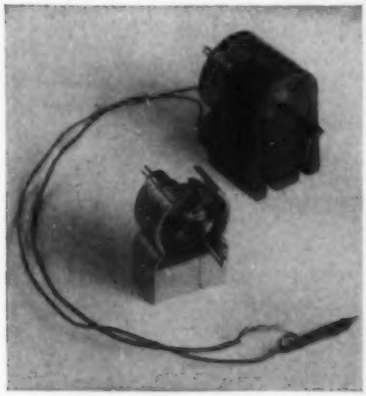
A series of low and high-speed, direct-drive synchronous motors, originally developed for magnetic recorders, are now available with speeds from 300 to 1800 rpm. Conbining a high torque rotor with flywheel and precision ground capstan, these motors provide accurate and constant velocities without gear reductions.

Standard capstans presently available and the large variety of motor speeds provide velocities of 1⅞, 3¾, 7½, 15 and 30 in. per sec. All motors are supplied with a magnetic shield eliminating the high-torque flux field from

the region of the capstan. Twelve cooling impellers located on the flywheel-rotor provide ventilation with maximum space conservation.

Motors are reversible and supplied with single or dual speed windings. A series of 50 cycle motors as well as the standard 115 v, 60 cycle line are also available. The motors measure approximately $5\frac{7}{16}$ dia and extend $4\frac{13}{32}$ in. from the mounting surface. Mounting is simply accomplished by a four hole flange. Technical Development Corp., 4060 Ince Blvd., Culver City, Calif.

For more information—
Circle 57, inside back cover



Toy Motor Works On Battery Power

A motor for use with toys, simple appliances and displays weighs $\frac{1}{8}$ oz and its dimensions are $1x1\frac{3}{8}x1\frac{3}{8}$ high, with a shaft 0.094 in. It draws 0.21 amp at 2 v, producing 2000 rpm. Torque is 0.11 in.-oz and horsepower is 1/2000.

Flashlight batteries of $1\frac{1}{2}$ to 6 v are used to run this motor, which is self-starting and reversible. Hi-Spex Mfg. Co., Inc., 319 Schulyer Ave., Kearny, N. J.

For more information—
Circle 58, inside back cover

Compact Toggle Switches

Six new three-position toggle switches, developed for use in aircraft, mobile, marine, electronic and appliance applications can make or break circuits in all three toggle lever positions. The latter is made possible by the use of two single-pole, double-

put real sales appeal in your products with MUELLER BRASS CO. forgings

Windows in this modern new Florida hospital supplied by Valley Metal Products Co.—subsidiary, Mueller Brass Co.

The aluminum hardware used on all the windows in this modern hospital is a good example of the sales appeal that can be built into a product with Mueller Brass Co. forgings. These forgings are smart in design, practical in operation, and low in cost. They can also be produced in natural bronze or chrome finish depending on the desires of the architect or builder.

All Mueller Brass Co. forgings have a dense, close-grained structure with a high tensile strength. Weight savings up to 40% are possible in the design of parts because of the close tolerances to which they can be produced. Less scrap and longer tool life result from the easy machinability of forged parts. Mueller Brass Co. is completely equipped to produce brass, bronze or aluminum forgings to your specifications. For complete details, write us today.

MUELLER BRASS CO.

PORT HURON 17, MICHIGAN

ANOTHER PROBLEM SOLVED by Tubular Rivet

PERMA-NUTS

problem Feed and set internally threaded shoulder bushings continuously in terminal clips using variable speed riveting machine that can be paced to match increasing dexterity of operator in positioning workpieces.

solution

TUBULAR'S Machine style 81-RN. Application of indexing table with 24 stations. Controls interlocked to provide proper setting sequence and range of speeds 4 to 200 per minute conveniently adjustable.

P.S. Send for complete data line of Perma-Nuts adapted to Automatic Insertion with TUBULAR'S Rivet Setting Machines. Contact TUBULAR RIVET, Dept. PE.

Tubular Rivet & STUD COMPANY

WOLLASTON 70, MASSACHUSETTS

BRANCH OFFICES: Buffalo, Chicago, Dallas, Detroit, Indianapolis, Los Angeles, Nashville, New York City, Philadelphia, San Francisco, St. Louis

throw basic switching units in each switch.

External dimensions of the switches are the same: $2\frac{1}{8}$ x $1\frac{5}{32}$ x $\frac{5}{8}$ in. Variations are in the combinations of momentary and detented toggle lever positions and in the fact that models 11AT1, 11AT2, and 11AT4 have standard AN-3234-1 basic switching while 11AT6, 11AT7 and 11AT8 are assembled with special impact-resistant, high-strength plastic-encased basic switching units.

The electrical rating of the basic switching units is: 30 v, dc, inductive -10 amp at sea level, 6 amp at 50,000 ft; resistive -10 amp; motor load -6 amp. They are UL-listed for 10 amp, 125 or 250 v, ac; $\frac{1}{2}$ amp, 125 v, dc; $\frac{1}{4}$ amp, 250 v, dc. Micro Switch, Freeport, Ill.

For more information—
Circle 59, inside back cover

Speed-Regulated Motor

Providing high starting torque of 110 in.-lb in a continuous-duty unit, this motor produces 1 hp at 12,000 rpm, regulated to 6 percent in speed variation. It draws 45 amp, operating over the d-c voltage range from 25 to 29.5, and regulates over a load variation of $\frac{3}{4}$ to 1 hp.

Sa'd to be engineered to withstand adverse temperature, humidity, pressure and other such environmental conditions, this motor has bypass capacitors built in at the armature and governor brushes to assist in the attainment of minimum radio interference in operation. Input connections are by means of a shielded positive lead and a grounded negative stud, although special arrangements can be supplied where required.

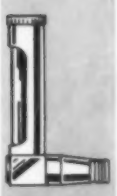
The model illustrated has a geared output shaft but the unit can be supplied with a plain shaft of the length required, or with splines, keyways or

LOOK TO THE LEADER... FOR LUBRICATING DEVICES

GITS

40 YEARS' LEADERSHIP

Yes, for 40 years GITS has been setting the standard for industry . . . solving tough lubricating problems . . . earning the confidence of manufacturers . . . it's the reason people say, "Call GITS first".



LOW COST

Yes, GITS oil cups can do a complete lubricating job for you . . . prolonging bearing life, reducing maintenance costs, cutting down-time, boosting production . . . and GITS oil cups cost so little.

WORLD'S LARGEST SELECTION

Yes, only GITS can offer you such a wide range of standard stock sizes. From *just one* source you can get *all* lubrication devices in *any design* for *any purpose.*

CONSISTENT TOP QUALITY

Yes, GITS is known for uniform quality in design, materials and machining . . . this means constant, dependable performance for you. Inferior products can cost you time and money. Demand the best . . . get GITS.

Oil Hole Covers • Oil Cups • Grease Cups • Bottle Oilers • Gauges • Gravity-Feed • Wick-Feed Constant Level • Vibrating Rod Styles • Threaded or Drive-Type • Elbow or Straight

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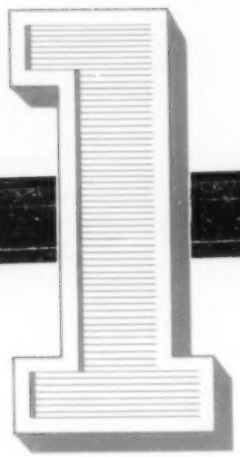
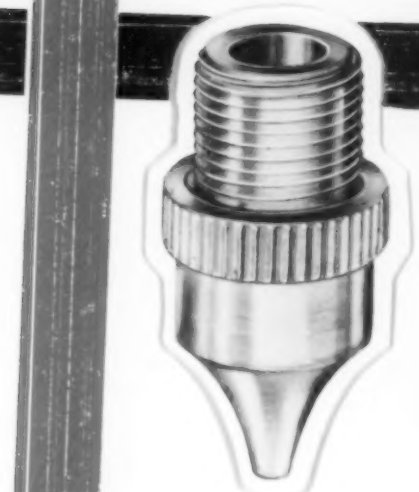
Write today for Free Catalog No. 60A. Use it as your handy reference for lubricating devices.

Why specify brass and get only





When aluminum gives you 3

Save thousands of dollars a year by specifying lightweight Kaiser Aluminum which gives you 3 times as many quality parts per pound as brass or steel.

Simply by asking your screw machine parts suppliers to always bid in aluminum as well as in brass or steel, you can make important savings every year.

How are these savings possible? In the first place, your screw machine parts supplier can make *three times more pieces* from a pound of aluminum than he can from a pound of brass or steel.

In addition, he makes other savings which can be passed on to you. Aluminum's workability often permits him to reduce his machine time, and extend his tool life. And aluminum provides him with a ready market for recovered scrap.

Even on the basis of quality alone, you will probably find that aluminum is the *preferred* material. Its unique combination of properties often gives you a better finished part than brass. Among these properties are light weight with strength, attractive finish, high resistance to corrosion, excellent conductivity of heat and electricity, heat and light reflectivity.

What's more, the use of aluminum often eliminates the need for expensive plating—a major economy that greatly reduces the price of the finished part.

More and more screw machine parts suppliers find aluminum EASY to machine

Screw machine operators all over the country are working aluminum on any existing screw machine at both high and low speeds.

Only a few easy changes are required to work aluminum instead of brass. For example, different tool angles are necessary. On long runs, carbide-tipped tools should be used. Simple tool re-designs provide the rakes, clearances and chip-breakers that are best for aluminum.

And to help screw machine shops machine aluminum most effectively, Kaiser Aluminum engineers are available to recommend angles proved best by operators experienced in aluminum.

On your future screw machine parts bids, always ask for the price in aluminum. The savings will be big, and the quality will probably be better!

If you would like more information, contact the Kaiser Aluminum sales office listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service

How you can get 3 parts instead of 1

Discuss the advantages of Kaiser Aluminum stock with your screw machine parts supplier.

Ask him to submit his bid in aluminum as well as in steel or brass.

That way you can see for yourself the money you save.

Kaiser Aluminum

setting the pace—in growth, quality and service

other such arrangements. This motor weighs 10.8 lb. Dalmotor Co., 1362 Clay St., Santa Clara, Calif.

For more information—
Circle 60, inside back cover

Miniature Straight and Angle Connectors

For use in aircraft, electronics, radio and general electrical industries, these connectors have been subjected to electrical and environmental tests in strict adherence to MIL-E-5272A and MIL-C-5015B. Shell types available include straight 90 deg angle and 45 deg angle plugs, all with integral clamps. A standard box mounting receptacle and hermetically sealed receptacles with steel shells are also available.

Shells and end bells are lightweight aluminum alloy; contacts are copper alloy, gold-plated; current rating is 5 amp. Insulators are nylon. Inserts are currently available in three sizes, with 10, 20, and 30-contact arrangements. Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

For more information—
Circle 61, inside back cover

Aluminum Electrical Conductor

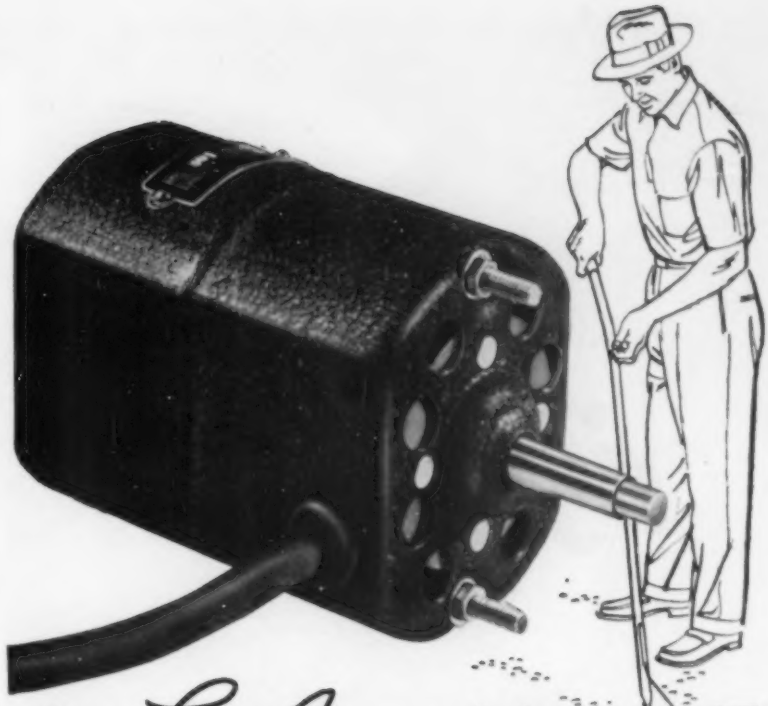
An aluminum alloy for conducting electricity is said to have superior mechanical properties, with a slight sacrifice in electrical conductivity, as compared with other aluminum alloys used for conductor purposes. Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.

For more information—
Circle 62, inside back cover

Time Delay Relay

In this electronic relay two timing ranges are available, 1.5 to 120 sec or 0.75 to 60 sec. Double-pole, double-throw contacts are provided for control of external circuits. Load contacts are rated at 5 amp, 115 v, ac.

Repetitive accuracy, with constant line voltage, is better than ±2 percent. Variations in line voltage will cause a slight increase or decrease in the



How Loyd Scruggs helps leading manufacturers of Electric Lawn Trimmers CUT COSTS and keep sales moving at a FAST CLIP

Cutting grass along walks and driveways is a rugged job—even for a machine. Manufacturers of lawn trimmers have used our "Custom-Built Motor Service" to great advantage. Scruggs Motors were designed to their specs . . . and complete satisfaction!

New plant facilities enable us to expand this service. And offer faster service, wider scope and lower pricing.

May we help you develop a better Power Tool? Fan or Blower? Heater? Electrical Appliance? Whatever your fractional horsepower application may be, a versatile Scruggs Universal AC-DC or Shaded Pole AC Motor can be built to your requirements.

Sample motor furnished on request. We'll send you a Scruggs Motor built to your specs. Write today for Data and Performance Chart. Immediate Service!

You can stake your reputation on Scruggs Motors

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Bijur Automatic Lubricating Systems designed into your machines *from the start* help you build an early lead in customer satisfaction.

And with Bijur you are *right* because for a quarter of a century Bijur Automatic Lubricating Systems have been part of efficient production programs.

Your customers prefer automatic lubrication in the equipment they buy because it increases production and reduces operating costs. Built into your original plans for machinery production, a Bijur Automatic Lubricating System can work for you by increasing customer acceptance, assuring bearing safety, and contributing to operating efficiency.

Call in a Bijur lubrication engineer. He is ready to help with your technical problems.

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LUBRICATING CORPORATION
Rochelle Park, New Jersey

Pioneers in Automatic Lubrication

preset time. Reset time of 3 percent of set time must be allowed between operations. A calibration control compensates for variations due to tolerances in components. This control is set at the factory to produce maximum rated time at rated line voltage.

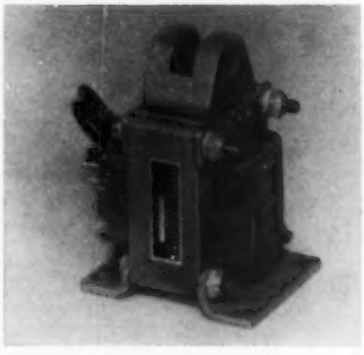
The MEK-2110 allows a choice of two sequences of operation. In one sequence, load contacts are de-energized during reset and timing, and energized when timed out. In the other sequence, load contacts are energized during reset, de-energized during timing, and energized when timed out. Sequences are obtained by interchanging terminal strip connections. Machinery Electrification, Northboro, Mass.

For more information—
Circle 63, inside back cover

Flexible Lining Material

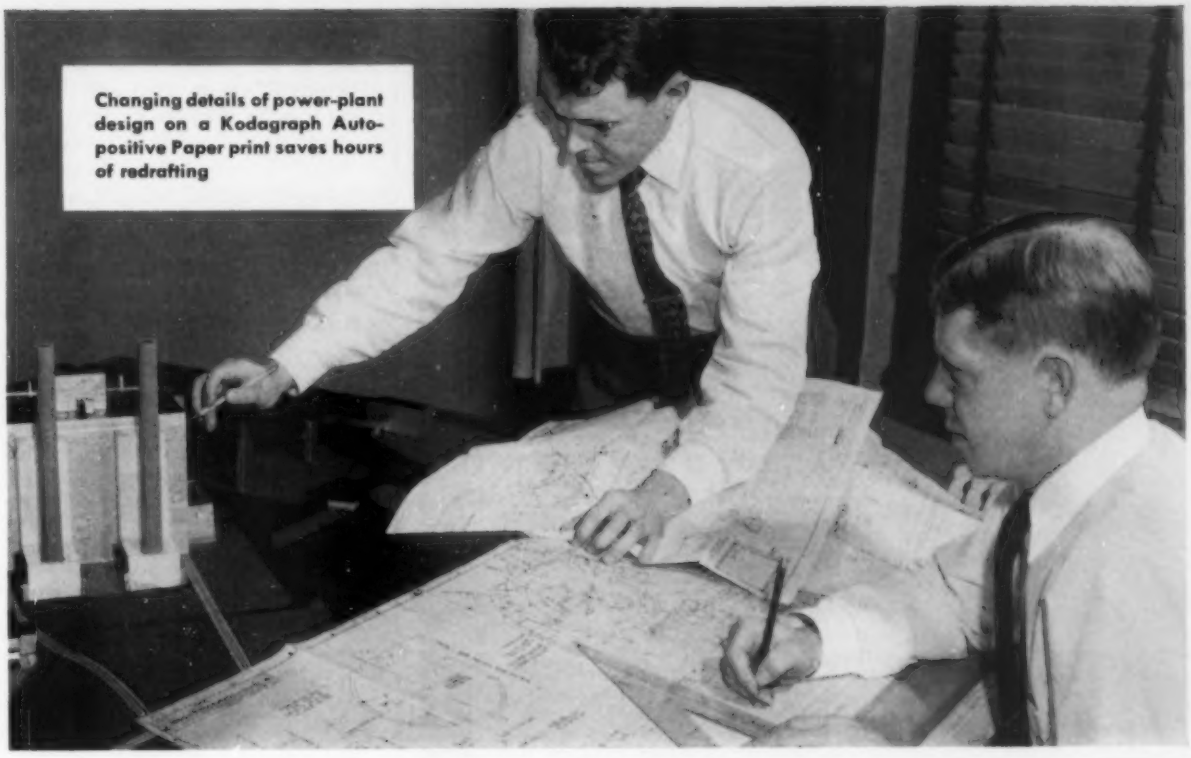
A flexible lining material that is asserted to combine excellent chemical, physical and electrical characteristics is available for numerous industrial lining needs. It is suggested for equipment such as tanks, fume ducts, tank cars and trucks and equipment used for mixing, storing, washing and transporting of corrosives. Kaykor Industries, Inc., 4437 Broad St., Yardville, N. J.

For more information—
Circle 64, inside back cover



Smaller, More Flexible Solenoids

With the same type of coil used in this company's magnetic starters, these solenoids are 22 percent smaller for the same rating as previous models, and are reported to give the same



Changing details of power-plant design on a Kodagraph Autopositive Paper print saves hours of redrafting

Toledo Edison Company reports on its use of Autopositive—

"One saving after another since 1947"

Shortly after Kodagraph Autopositive Paper was introduced, the Toledo Edison Company, Toledo, Ohio, began exploring its possibilities for engineering drawing reproduction.

Here was a revolutionary photographic intermediate paper which produced positives directly from positives—no negative step. It could be exposed in standard print-making equipment . . . processed in standard photographic solutions. *Entire operation in ordinary room light, too.* Jobs which had been difficult and costly became easy and economical—Kodagraph Autopositive Paper costs only a few cents a square foot. Some typical savings at Toledo Edison *which you can duplicate* are listed here.

☐ **Old prints and intermediates reclaimed.** No time lost retracing. Autopositive Paper strengthens weak line detail, cleans up backgrounds. Toledo Edison now can get intermediates which have dense photographic black lines on an evenly translucent paper base. *Original quality or better!*

☐ **Opaque originals no problem.** Many of Toledo Edison's forms, charts, operating maps, etc., are on opaque stock—some two-sided. Data is added to these in pencil or by typewriter. Then Autopositive reproductions are made and used to produce the direct-process prints needed for distribution. The 1954 Annual Budget, for example, was reproduced in this manner. *Autopositive saves time and dollars for all departments.*

☐ **Print-making simplified.** Toledo Edison runs Autopositive intermediates at uniform, practical speeds in its direct-process machine . . . gets sharp prints time after time. *Autopositive lines do not smear, smudge, or lose density.*

☐ **Drafting shortcuts.** An Autopositive print is made of a drawing which has to be altered. The obsolete detail is eradicated or scissored out, and another Autopositive is made. New design is then added, and the job is completed without redrafting.

☐ **Photo-lasting file copies.** Toledo Edison also finds that Autopositive intermediates will not turn yellow or become brittle . . . are ready to produce sharp, legible prints whenever needed.

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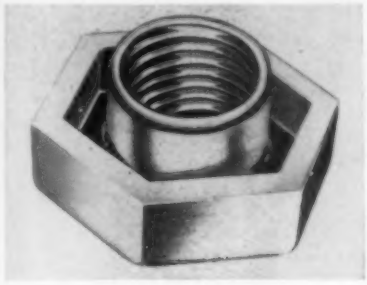
power in less space. A selection of 24 different ratings from nine basic frame sizes are available in both push and pull, dc and ac, 25 to 60 cycles, 24 to 600 v forms. Nominal ratings at maximum stroke, 60 cycle, are: ½ in. pull from 3 to 40 lb; 1 in. pull, from 1.4 to 36 lb; ½ in. push, from 2.0 to 33 lb; and 1 in. push, from 4.3 to 28 lb.. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 65, inside back cover



Lightweight Hex Nut

It is reported that tests of this hex nut show that it exceeds all Bureau of Aeronautics and USAF specifications for the AN 363 high temperature nut and the AN 365 standard hex nut. Yet this new fastener is dimensionally interchangeable with the AN 364 "thin" shear nut. Of cadmium-plated, spring steel construction, the nut's upper threads are made elliptical and highly resilient allowing all threads to carry the actual load, and eliminating the necessity of an auxiliary locking device. Currently the new nut is available in 6-32, 8-32, 10-32, ¼-28, $\frac{5}{16}$-24, ⅜-24 and $\frac{7}{16}$-20 tap sizes. Kaynar Co., 820 E. 16 St., Los Angeles, Calif.

For more information—
Circle 66, inside back cover

Flexible Plastic Piping Withstands Sunlight

Polyethylene-base, flexible plastic pipe, designed to overcome the deteriorating effect of sunlight, is said to contain no anti-oxidants or pigments that would tend to make it toxic. This new piping can be used to convey potable liquids, slurries and chemicals. It is also suitable for use

as electrical conduit, especially where it is exposed to sunlight.

A 100-ft length of this new ¾ in. pipe weighs only 13 lb. It is furnished in nine standard sizes up to 6 in. dia. A complete line of fittings are available. Pipe is shipped in continuous coils up to 400 ft length, depending upon diameter. Munray Products, Inc., 12400 Crossburn Ave., Cleveland 11, Ohio.

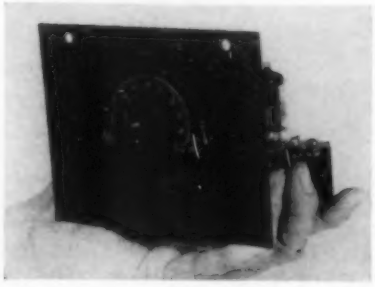
For more information—
Circle 67, inside back cover

Thermocouple Insulation For 2000 F

A 2000 F thermocouple wire insulating method consists of thermocouple wires surrounded and insulated by pure magnesia and inserted and swaged into a metal sheath. It is available in chromel-alumel, iron constantan and platinum-rhodium with Inconel, stainless steel, aluminum, copper and other sheath materials. The outside diameters are from 0.04 to 0.32 in. with two wires.

The material is excellent for use in making completely gas-tight thermocouples. It can be sharply bent and mounting flanges can be welded to the sheath without destroying the insulation. Aero Research Instrument Co., 1901 N. Hermitage Ave., Chicago 22, Ill.

For more information—
Circle 68, inside back cover



Electronic Timer For Automatic Machines

This timer is suitable for push button, foot switch or other actuation of controlled interval operation of spot welders, heat sealers, punch presses and vending, washing or molding machines. The design of Type 12

with a CAMBRIDGE

WOVEN WIRE CONVEYOR BELT!

Cut corn is blanched, cooled and frozen on Cambridge Woven Wire Conveyor Belts. Entire operation is *continuous and automatic*, requires no manual handling until discharge from freezing tunnel.

Regardless of whether your process temperatures range from sub-zero to as high as 2100° F . . . whether you use water rinses, acid pickles or other corrosive processes . . . a Cambridge woven wire belt can help you cut manufacturing costs by contributing to automation . . . continuous, automatic production.

Cambridge belts are all metal and can be woven from any metal or alloy. Thus, they are impervious to damage from heat, cold or corrosive conditions. That's why they can be used to process parts or materials while moving from one location to another.

Because of their open mesh construction they permit free circulation of process atmospheres, free drainage of process solutions. They are available in a wide range of specifications for carrying light or heavy loads, large or small parts.

Special raised edges or cross-mounted cleats to hold your product on the belt during flat or inclined movement are easily supplied.

Get the full story—FREE! Learn how Cambridge Woven Wire Conveyor Belts can help you boost efficiency by continuous, automatic production . . . *automation!* Write today for your copy of this manual of belt applications. It's the most complete text available.

Or, for immediate advice, call in your Cambridge Field Engineer. You can rely on him to make just the right recommendation for you. Look under "Belting-Mechanical" in your classified phone book, or write direct.

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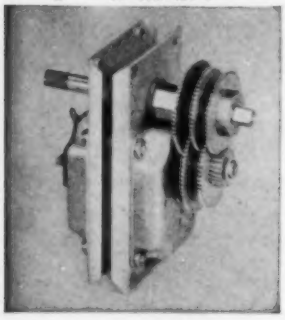
EEPCO-DESIGNED MOTORS

Manufacturing X-Ray equipment calls for precision and dependability in every part. That's why, when the nation's three leading manufacturers of X-Ray machines chose the motor that moves the delicate negative holders, they selected motors designed and built by EEPCO.

These tiny motors of 1/500 h.p. (intermittent service) provide the reliable, steady source of power that revolves the negative changing mechanism. After a photo is made, the exposed negative with its lens and shutter, are automatically moved aside and a new unit moved into the ready position. Handling this task demands an even, slow application of power to avoid damage to the delicate mechanism. This is typical of the many unusual applications to which EEPCO-designed motors have been put.

If your particular problem calls for special design, or merely for standard motors that can handle the toughest service, you'll find that EEPCO is the source on which to depend. Out of the many unusual requirements filled by EEPCO engineers has come experience unsurpassed in industry and always at your disposal.

Equally important, the EEPCO plant is well-equipped and staffed to turn out motors for you on a mass-production, low-cost basis when necessary.



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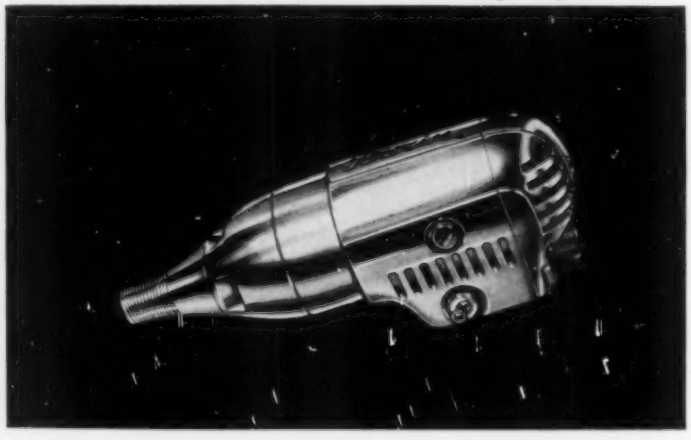
• DC MOTORS & GENERATORS • SHADED POLE MOTORS (2-4-6 Pole) • P-M AC GENERATORS

Precision die castings for



the Precise Hand Grinder

FEDERAL DIE CASTING CO.
2228 N. ELSTON AVE. CHICAGO, 14, ILL.
PHONE ARmitage 6-4803

MC utilizes an electronic circuit with two filament-less, cold cathode tubes so that warmup time is eliminated for accurate timing periods ranging from 0.05 to 7 sec. Duration of the interval is continuously adjustable. Output of the electronic circuit is fed into a single-pole, double-throw electromagnetic relay with normally open, 10-amp contacts.

This internal control requires only 0.1 w for operation from any 105/125 v, 25-400 cycle, a-c source. It is supplied for panel mounting or with a lacquered steel box measuring 3 x 4 x 5 in. G. C. Wilson & Co., 1950 Eighth Ave., Huntington, W. Va.

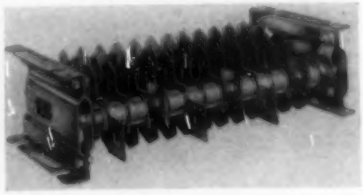
For more information—
Circle 69, inside back coevr

A-c Line Voltage Regulator

This new regulator is exceptionally small in size and weight, said to be due to the extreme efficiency of the power circuit. The self-saturating circuit was designed for a very low output impedance which permits transient overloading without undue loss of regulation.

The control section is basically a magnetic amplifier with a cold cathode-type tube used as a voltage reference. An alternate tube is included as a standby. Test switches permit routine checks of both tubes to make certain they are operable. Power Equipment Co., Detroit, Mich.

For more information—
Circle 70, inside back cover



Welded Grid Resistors

As a unit, the complete grid assembly can be withdrawn from its frame without disturbing the grid box and frames or other boxes in the resistor stack. The removal of four bolts makes the "draw-out" feature possible. A different type of grid rod and end plate construction is said to

automaticlly compensate for thermal expansion of the individual grids and also permits easy replacement of the grid assembly. Welded current-carrying junctions provide a continuous unbroken path for constant resistance values, unaffected by corrosion or changes in grid rod pressures. Individual grids are non-breakable, punched from a chromium steel alloy, and mounted in an unique arrangement to attain efficient heat radiation. Continuous current capacities up to 180 amp per box in ratings from $\frac{1}{10}$ to 10 ohms are available. All grids are insulated for 600 v service. Cutler-Hammer, Inc., 296 N. 12 St., Milwaukee, Wis.

For more information—
Circle 71, inside back cover

Standard Size Power Supplies

Having developed a self-saturating open bridge circuit, this manufacturer offers a group of power supplies that are listed as standard sizes and are designed for heavier power requirements. The new bridge circuit corrects for fluctuations of a-c input line voltage as well as variations in the d-c load, and is not dependent upon the accurate maintenance of the a-c line frequency. As a result, this new series can be effectively used with emergency, portable or standby power units as well as on utility lines.

The circuit uses a magnetic amplifier bridge selenium rectifier in most sizes. The use of a VR-105 voltage regulating tube as a reference assures dependability. Another VR-105 is provided as a standby. Power Equipment Co., Detroit, Mich.

For more information—
Circle 72, inside back cover

Silicone Grease

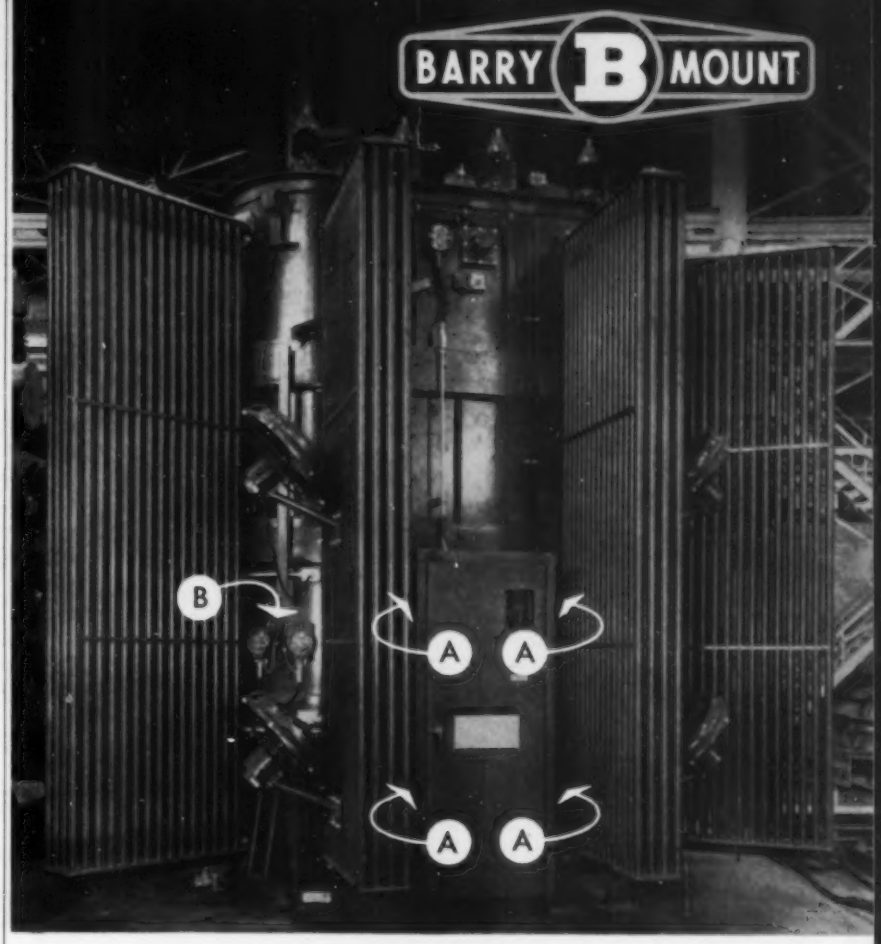
A protective grease, based on silicone fluid, is non-melting and non-freezing in temperatures ranging from −70 up to 400 F. The grease is water-repellant and chemically inert. One application usually lasts an entire season, it is asserted, because this grease does not wash off.

This protective compound was designed as a lubricant for door weather-

for control of

SHOCK and VIBRATION

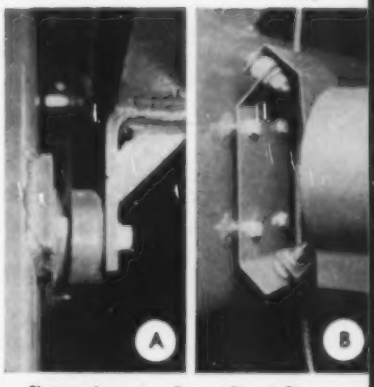
BARRY B MOUNT



"Definitely improved the reliability of the transformer accessories and, consequently, the performance of our transformers"

Vibration is inevitable in the operation of large power transformers like this 20,000 KVA unit. But harmful effects are prevented by the Barrymounts that isolate temperature indicators, and control cabinets containing switches, relays, gages, and other sensitive instruments. In this installation, small #302 unit Barrymounts isolate the liquid-temperature indicators and medium-size #C-2000 Barrymounts isolate the control cabinet, prolonging the life of delicate equipment and protecting the reliability of transformer performance.

Wherever vibration is present, Barrymounts will keep it under control. Let us tell you how to protect your products from shock and vibration. Ask for Bulletin EG-54 "This is Barry."



Photographs courtesy General Electric Company

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SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

'Diamond H' Miniature, Hermetically Sealed, Aircraft Type Relays

Shown Actual Size

HAVE A **WIDER RANGE** OF PERFORMANCE CHARACTERISTICS

IF YOU need a relay that will operate consistently under extremely critical or downright adverse conditions, there's an excellent possibility your requirements can be readily met by one of the multitude of variations possible with the basic "Diamond H" Series R relay. Originally designed to meet all requirements of USAF Spec. MIL-R-5757B, they far surpass many. They're adaptable to a wide variety of applications . . . guided missiles, jet aircraft, fire control and detection, radar, communications, high speed camera, geophysical and computer apparatus, for example.

TYPICAL PERFORMANCE CHARACTERISTICS

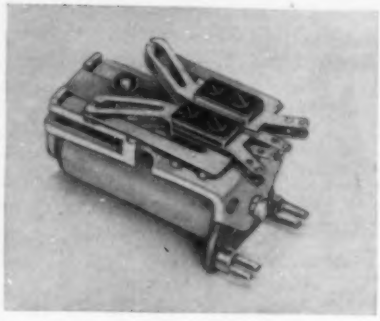
Vibration Resistance:	10-55 cycles at 1/16" double amplitude 55-500 cycles at 15 "G" 55-1,000 cycles at 15 "G" 55-2,000 cycles at 10 "G"
Temperature Range:	—55° to + 85°C. —65° to + 125°C. —65° to + 200°C.
Coils:	Resistances—1 ohm to 50,000 ohms Arrangements—single coil; two independent coils, either or both of which will operate unit
Insulation Resistance:	1,000 megohms at room temperature 100 megohms at 200°C.
Dielectric Strength:	450 to 1,250 V., RMS
Operating Time:	24 V. models 10 ms. or less; dropout less than 3ms.
Contacts:	30V., D.C.; 115V., A.C.; 2, 5, 7½ and 10A., resistive; 2 and 5A. inductive. Minimum 100,000 cycles life. Low interelectrode capacitance — less than 5 mmf. contacts to case; less than 2½ mmf. between contacts. Special Ratings: to 350 V., D.C., 400 MA., or other combinations including very low voltages and amperages or amperages to 20.
Operational Shock Resistance:	30, 40 and 50 "G" plus
Mechanical Shock Resistance:	up to 1,000 "G"
Mounting:	9 standard arrangements to meet all needs — plus ceramic plug-in socket.
Size:	1.6 cu. in.
Weight:	4 oz. or less

Call on "Diamond H" engineers to work with you in developing a variation to meet your specific requirements.

THE HART MANUFACTURING COMPANY
206 Bartholomew Avenue, Hartford, Connecticut

strips, hood lacings, hood bumpers and all other rubber parts that produce squeaks when not lubricated. It is also believed to be effective as a weatherstrip freeze-preventive around door and trunk openings, minimizing checking and cracking of exposed weatherstrip. The grease is packed in 1, 2 and 8 oz tubes. Jill Mfg. Co., Revere, Mass.

For more information—
Circle 73, inside back cover



Miniature Relay With Bifurcated Contacts

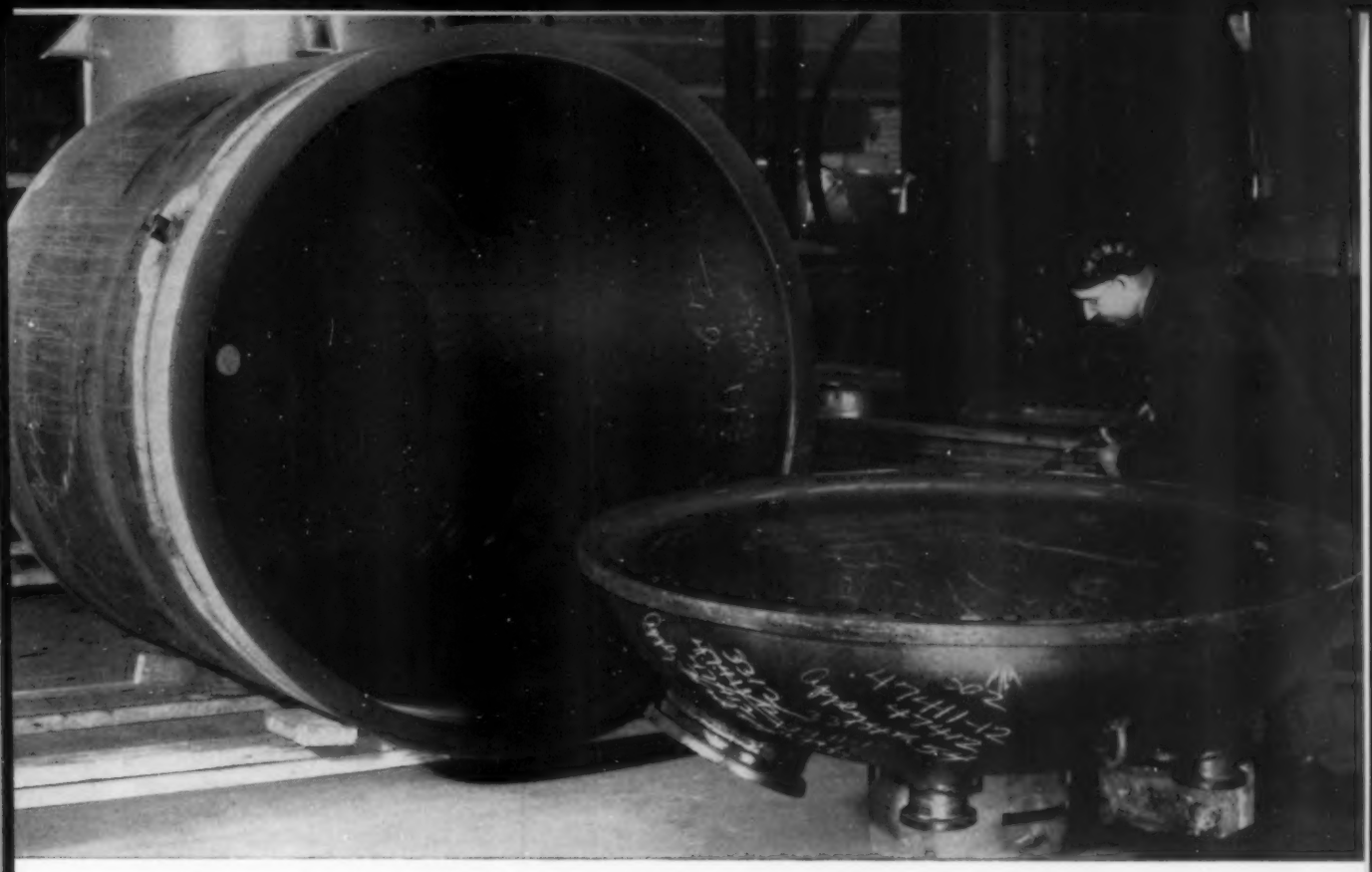
Development of relays with twin contacts for reliable switching of extremely low voltage and low current is accomplished by the flexibility of the long bifurcated contact springs. It is asserted that this enables the twin points to make contact independently. In this way, contact is assured even when one is blocked by dust or grit.

These contacts are available with Series 22 relays, for ac or dc, in open types, as well as with a wide selection of hermetically sealed and dust-tight enclosures. Magnecraft Electric Co., 1442-P W. Van Buren St., Chicago 7, Ill.

For more information—
Circle 74, inside back cover

Hand-and-Foot Operated Valves

A new hand-and-foot operated, four-way valve with built-in, full-capacity, flow-control meters of the venturi type has been designed for the control of double-acting air or hydraulic cylinders. These valves are built for heavy-duty service and have one balanced spool, using renewable "O"



SSW forged ring flanges enable Pfaudler to increase pressure capacities of glass-lined tanks 50%

By switching to Standard Steel forged ring flanges for manholes and larger openings in their glass-lined tanks, The Pfaudler Company, Rochester, N.Y., has increased normal pressure capacities 50% above previous limits. These rolled, weldless flanges replace integral flanges formed in the tank wall or flanges formed from steel plate and welded to the tank shell.

Standard Steel forges these 24″ to 84″ ring flanges to heavier and more efficient shapes than Pfaudler could get previously. An increase in the flat surface area of the flanges permits increased pressures. The switch to forged flanges also has eliminated the serious problem of warping during annealing or stress relief before applying glass linings.

SSW shapes these rings as close as possible to finish dimensions in the rolling operation to minimize the amount of metal removed in roughing and finishing cuts. However, ample material is available for forming a bead on the edge of the flange to retain the clamps which hold the covers tightly on the gaskets.

Pfaudler's use of Standard Steel's weldless flanges is just one of the very diverse ways ingenious users are improving their products by switching to roll forged rings and flanges (12″ to 144″ O.D.). It'll pay you, too, to investigate how they can benefit you. For more facts please write to Department 8635, Standard Steel Works Division, Baldwin-Lima-Hamilton Corporation, Burnham, Pennsylvania.

BALDWIN BLH LIMA-HAMILTON

Standard Steel Works Division

Burnham (Mifflin County), Pa.

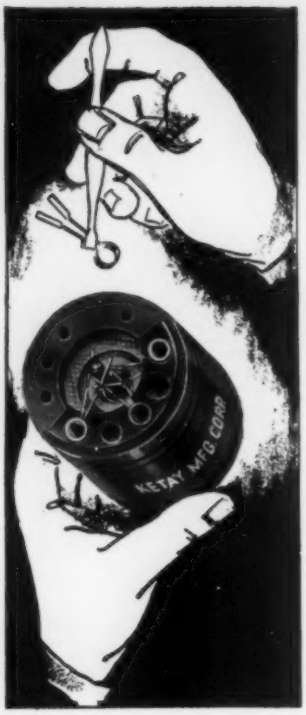
BALDWIN-LIMA-HAMILTON

General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS

The accurate transmission of electrical impulses through a movable contact is dependent solely upon the properties of that contact. Illustrated at the right is a Ketay Synchro, which is the heart of many precision indicating, communicating and control devices. Ketay is noted for Synchros and Resolvers capable of extreme accuracy. Therefore, Ney Precious Metal Contacts have been selected because of their practically ideal physical and electrical properties.

Ney Precious Metal Alloys have high resistance to tarnish, are unaffected by most industrial corrosive atmospheres, and are fabricated into slip rings, brushes, commutator segments, wipers, contacts and similar components for use in electrical instruments. Call on the Ney Engineering Department for help in selecting the right Ney Precious Metal Alloy which will improve and prolong the life and accuracy of your instruments.



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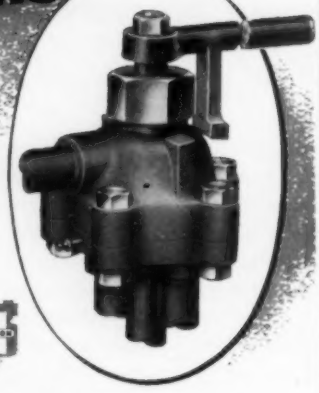
Specialists in Precious Metal Metallurgy Since 1812

NICHOLSON VALVES

for Air & Fluid Power



Solenoid, Motor, Lever, Foot Types for Every Medium

Nicholson furnishes valves for cylinder control, distributing, metering and for many special operating cycles. Installations in a wide range of industries have been in constant service for well over 25 years. In addition to their long wear and minimum maintenance, Nicholson valves feature: specially treated hard seats and lapping flat discs which actually become tighter with use; choice of 6 metal combinations to suit your specific service; positive protection against grit. Size, ⅛" to 2½". Pressures to 5000 lbs.

Send for Catalog

W. H. NICHOLSON & CO.
TRAPS · VALVES · FLOATS
200 Oregon Street, Wilkes-Barre, Pa.

ring packing. The flow control meters allow full-line volume without loss of pressure and line-pressure variation will not affect valve function.

This basic valve is also available for remote pilot operation, cam, single or double solenoid together with time-delay features. Non-corrosive throughout, this extremely compact valve is available in four standard pipe sizes, ¼, ⅜, ½ and ¾ in., for air, oil or water, in the pressure range of 0 to 150 psi. Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.

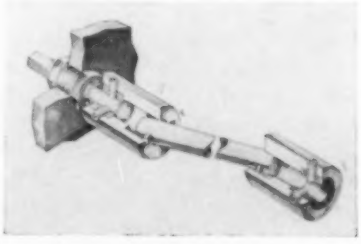
For more information—
Circle 75, inside back cover

Potentiometer for Service Over 125 C

Besides a temperature rating of over 125°C, this potentiometer has a new low mass wiper which will permit operation under severe vibration and acceleration conditions. A new coupling for the ganging cup provides zero backlash and low torque, resulting in accurate phasing and ease of cup removal.

Fewer internal parts provide a clean internal design, utilizing new materials and techniques. Nominal function angle is 330 deg and nominal contact angle is 345 deg. Power rating is 2.5 v. Terminal voltage is 400 v, dc, dependent on resistance and voltage rating of unit and torque is 1.5 in.-oz per cup. Daven Co., 191 Central Ave., Newark 4, N. J.

For more information—
Circle 76, inside back cover



Insulated, Zero-Backlash Universal Coupling

Joining of two shafts offset from each other as much as 30 deg. and separated by more than 3 in. is possible with this insulated universal

coupling. The device is designed for joining two ¼ in. shafts. Typical applications are connection between the instrument panel of equipment and remote rotating components and the zero-backlash coupling of instrumentation components.

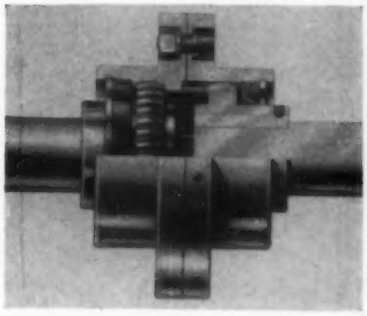
The coupling is molded of nylon with nickel-plated brass inserts, and is supplied with set screws and coupling pins. It is used with ¼ in. coupling shaft of any length (not supplied) and is finished in accord with military specifications. Jan Hardware Mfg. Co., Inc., 75 N. 11 St., Brooklyn 11, N. Y.

For more information—
Circle 77, inside back cover

Miniature Relay

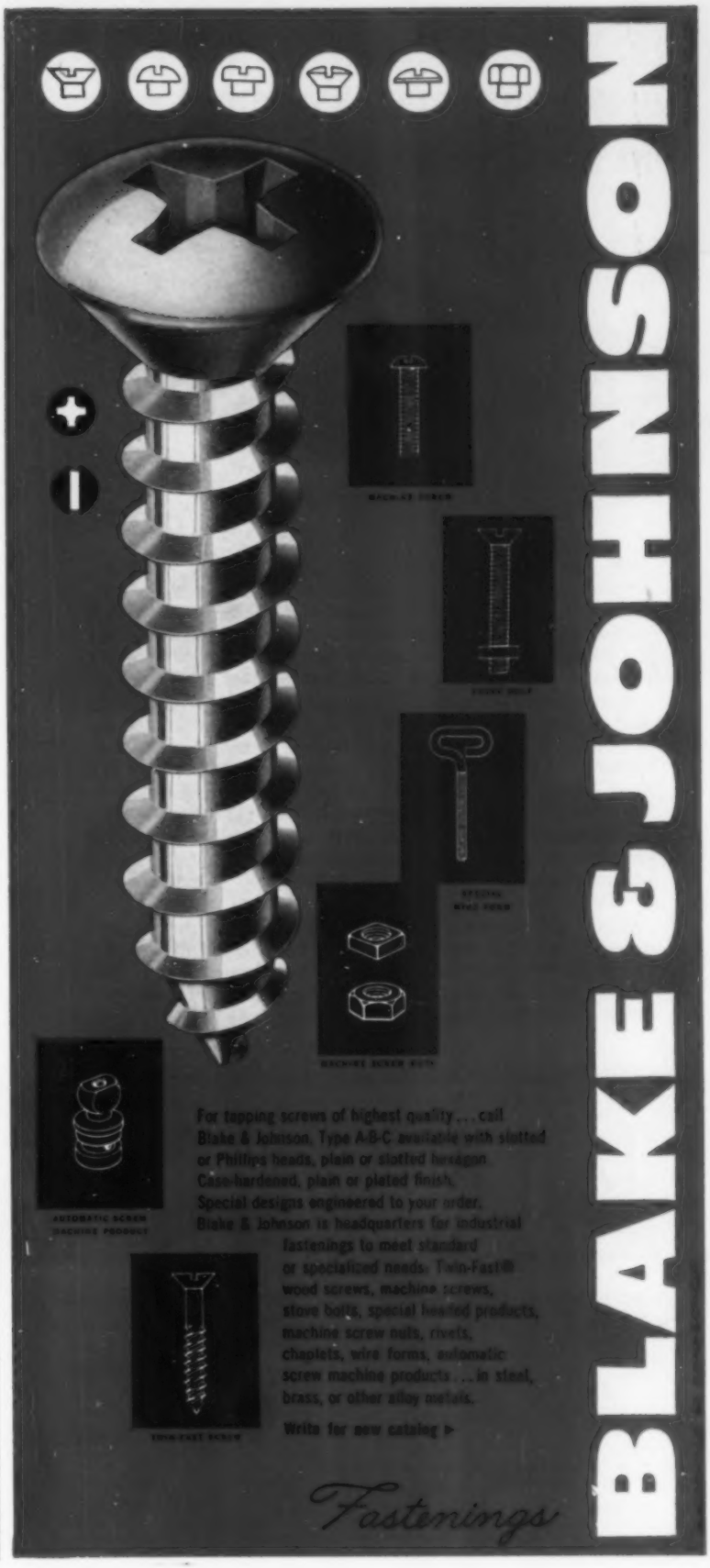
This relay can be actuated by solar battery or photo-cell, since it only requires 18 milliwatts to effect contact closure. The contacts and actuating elements are made of magnetic rods, sealed in glass, and it is asserted that this differs from conventional relays in that only the contacts are sealed. This reduces the possibility of seal contamination. These relays are available in a variety of sizes for varied applications, and units having up to 109 contacts in one assembly have been built. G. M. Giannini & Co., Inc., East Orange, N. J.

For more information—
Circle 78, inside back cover

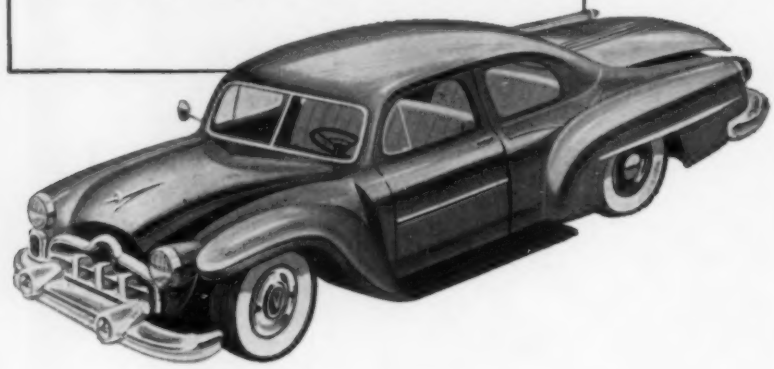


Coupling With Spherically Cut Gears

This coupling has gear teeth which are cut on a segment of a sphere. It has been applied successfully in aircraft and other specialized fields. The male teeth of each coupling half are


BLAKE & JOHNSON
For tapping screws of highest quality . . . call Blake & Johnson. Type A-B-C available with slotted or Phillips heads, plain or slotted hexagon. Case-hardened, plain or plated finish. Special designs engineered to your order. Blake & Johnson is headquarters for industrial fastenings to meet standard or specialized needs. Twin-Fast® wood screws, machine screws, stove bolts, special headed products, machine screw nuts, rivets, chaplets, wire forms, automatic screw machine products . . . in steel, brass, or other alloy metals.
Write for new catalog ▶
Fastenings

Does your servo system end up like this?



Of course, you've never bought an automobile in pieces, picking up a bumper here, a carburetor there, a clutch somewhere else. Even if you *could* arrive at the appearance and performance of a finished car, chances are it would require countless hours of work and a factory-full of fabricating equipment to integrate the odd sized parts.

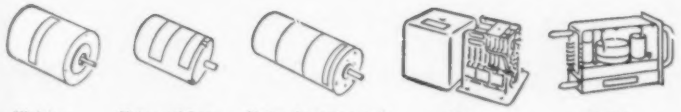
Surprising, then, how many companies build servo systems just this way. Buying parts from different manufacturers . . . putting them together and hoping for an ideal system. Either the final result is far below potential efficiency, or the time, labor, machinery, and materials wasted in trying to "fit" the components together boosts the cost astronomically.

Experience proves that complete assemblies of Transicoil components not only assure improved system performance but actually cost less than the total purchase price of the individual components acquired from several sources.

If you are now purchasing servo components from several manufacturers, a serious talk with Transicoil will pay you dividends in lower costs and a better system. But if you require only one component, you can be sure of optimum performance from the Transicoil units you specify.

TRANSICOIL

CORPORATION 107 GRAND STREET NEW YORK 13, N.Y.



Miniature Control Motors | Motor and Gear Train Assemblies | Motor, Generator, and Gear Train Combinations | Servo Amplifiers | Plug-In Assemblies

cut on a true spherical arc while the internal teeth are cut with a straight root. Thus, whenever misalignment occurs, the curved tooth maintains a constant area of contact with the internal tooth. Coupling flexibility is said to be independent of excessive backlash between coupling teeth, point contact or springs.

The new coupling is suitable for angular misalignments up to ± 3½ deg on each coupling half, giving a total of 7 deg. Special couplings are available for up to 14 deg misalignment.

The couplings are available from stock in sizes 0 through 6 (maximum bore 6⅝ in.) while larger couplings for heavy duty service are made to order. Philadelphia Gear Works, Erie Ave. and "G" St., Philadelphia 34, Pa.

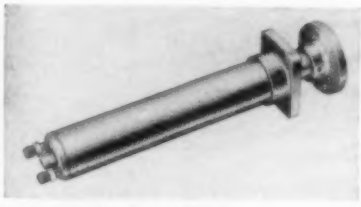
For more information—
Circle 79, inside back cover

Copper-Clad Printed Circuit Laminate

A copper-clad etched circuit laminate is said to have a bond electrically equal to the laminate itself which improves with heat and age.

Solder tests have permitted a guarantee of resistance to 230-240 C without blistering, and heat tests indicate that no change occurs during a half-hour at 150 C. Mica Insulator Co., Schenectady, N. Y.

For more information—
Circle 80, inside back cover



Air Cylinder With Keyed Linear Motion

A double acting, non-rotating shaft air cylinder is reported to provide perfect registration on each stroke without the use of exterior guides. The unit should be useful in positioning work for welding, painting, machining, assembly or where one or

more pressure points are required which are not on the axis of the cylinder.

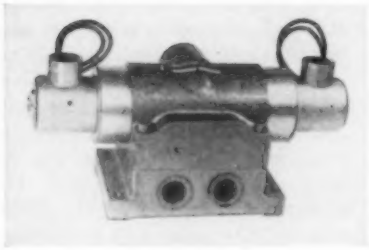
Both parts are at the rear of the cylinder which permits a more compact installation than is possible with inlets at each end. Shaft is $\frac{7}{8}$ in. dia at the working end and is available with 4 in. dia flange or with clevis. Bore of the cylinder is 2 in. made in —1 to 6 in. stroke. Summitt Tool & Mfg. Co., 2907 Summit St., Toledo 11, Ohio.

For more information—
Circle 81, inside back cover

Fhp Split Capacitor Motor

This motor is available from 1/20 to $\frac{1}{3}$ hp and can be used to replace a shaded pole unit where greatly increased efficiency is needed as in window air-conditioning units. Reported to require 67 percent less running current, the new motor is $5\frac{1}{2}$ in. in diameter. One, two or three speeds are available and single or double shaft extensions resilient and rigid or thru-bolt mounting are provided to meet particular design requirements. Marco Industries, Inc., 830 Terrace Blvd., Depew, N. Y.

For more information—
Circle 82, inside back cover



Air or Hydraulic System Control

Four-way valves for service up to 200 psi have only one moving part, a one-piece spool, which carries the only moving seals employed. These are standard "0" rings, stocked by most industrial supply houses and which can be replaced in a few minutes.

These new valves are readily adapted to sub-base, manifold, panel, console

"SHOT DOWN" to SAFETY

. . . at SUPERSONIC speed

with the help of PRECISION INVESTMENT CASTINGS by HITCHINER

EMERGENCY BAIL OUT!

And at sound-barrier speeds, a revolutionary bailout technique had to be found.

So engineers at Stanley Aviation Corp., Buffalo, N.Y., developed an ejection seat that catapults **downward** *from a plane and a lap belt that automatically opens, frees the airman from the seat, and sequences parachute opening.*

The cost of this priceless protection? Slashed to a minimum through the use of HITCHINER Precision Investment Castings. By combining several small parts into one . . . building complex shapes without added machining . . . using beryllium copper and stainless steel, HITCHINER achieved lower total production costs plus lighter weight with extra strength — economies and design achievements not possible with other production methods.

For a new approach — the logical solution to **your** *small parts problems — consult HITCHINER. Send us your drawings. Mail the coupon for informative FREE booklet.*

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CO. NAME _____
CO. ADDRESS _____
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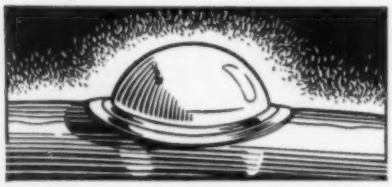
Aircraft seals



— extruded, molded or fabric reinforced — are now available in COHRLASTIC HT — the new, high tensile strength, high tear resistant silicone rubber

Aircraft seals must be capable of resisting sub-zero temperatures and possess high tensile strength, high tear resistance, high stability after long exposure to ozone, oxidation, sun and weather.

COHRLASTIC HT meets all these requirements with values plus

In many cases, extruded unreinforced COHRLASTIC HT seals can completely replace more costly reinforced seals. When necessary — where maximum durability is required — COHRLASTIC HT reinforced with dacron and other fabrics is available.

Resiliency, low compression set, simplicity of installation and low replacement cost are some of the exclusive characteristics of this important new development. And the applications are many — cargo doors, camera doors, nacelle doors, radomes, canopies, escape hatches, to name a few. Literature and samples gladly supplied on request.

COHRLASTIC

408 EAST ST. • NEW HAVEN, CONN.

PRODUCT OF THE Connecticut HARD RUBBER COMPANY

MANUFACTURERS OF SILICONE RUBBER COATED FABRICS REINFORCED WITH FIBERGLAS, NYLON, DACRON AND ORLON FOR SPECIFIC APPLICATIONS. MOLDED SHEETS, CUSTOM PARTS, EXTRUSIONS, PRESSURE-SENSITIVE TAPES, HIGH TEMPERATURE DE-ICING SYSTEMS, NON-LINEAR MOUNTS, CONDUCTIVE GASKETS.

or conventionally piped installations. A line of standard attachments provide for operation by lever, palm button, foot pedal or treadle roller, cam, solenoid pilot or remote bleeder button. Parts are standardized and interchangeable so that virtually any type valve may be assembled or repaired from a minimum stock of basic parts. One body casting accommodates $\frac{3}{8}$ or $\frac{1}{4}$ in. NPT ports; the second, $\frac{3}{4}$ and 1 in. NPT ports.

Lightweight body is cast aluminum and the liner is hard-drawn brass, with an aluminum spool. Modernair Corp., 400 Preda St., San Leandro, Calif.

For more information— Circle 83, inside back cover

Quarter-Turn Locks Sheet Fastener

A one-piece fastener that is said to resist severe and prolonged vibration is applied blind from one-side. It is well adapted to take-up in commercial sheet metal tolerances. Once snapped in place, the Q-4 is self-retaining in the outer sheet or panel.

Cost savings with the new fastener are reported on a unit basis and also on a material basis. One large manufacturer is said to be cutting production costs by using a Q-4 to replace a special screw and a retained nut. Sizes are available to accommodate various panel thickness. St. Charles Road, Elgin, Ill.

For more information— Circle 84, inside back cover

Bin and Hopper Vibrators

Two new air vibrators, of 1 and 5-in. piston dia, are for use in bins, tanks, hoppers and chutes handling granular

and powdered materials, ranging from wet sand and gravel to coal, cement, grain, food stuffers, cinders, ice, feed and chemicals. All Type F vibrators operate on 25 to 100 psi continuous line pressure. Maximum efficiency is obtained at 80 psi. They are designed for continuous or intermittent operation, and can be used on bins containing from one to several hundred tons of materials. Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland 13, Ohio.

For more information—
Circle 85, inside back cover

High-Voltage D-c Tachometer Generator

A d-c tachometer generator, designed for a variety of control applications, as well as for accurate speed indications, provides high voltage output of 50 v at 1000 rpm. It is an ideal pilot exciter for many control applications, according to the manufacturer.

The new tachometer is totally-enclosed and can be either flange- or foot-mounted to be direct-coupled, geared or belt-driven. Capable of use in either horizontal or vertical position, the unit's conduit box with a ½-inch straight pipe thread permits use of conduit if desired.

The shaft extension on the unit's pulley end is ⅞ in. dia and ⅱ in. long with a flat section and stub shaft on the opposite end for hand tachometer measurements. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 86, inside back cover

Heavy-Duty Quick-Seal Coupling

Quick-seal, leak-proof couplings are now available in heavy-duty models for high-pressure, heavy-flow applications in the steel, oil, chemical, construction and other industries. A simple construction is said to make the hose line leak-proof the moment the nipple is seated in the coupling body and seals it tighter the higher the pressure builds up. In addition, the coupling has a full-swiveling feature that prevents hose kinking. The coupling is made in several designs

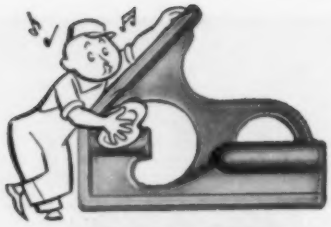
Fusionweld IS TOUGHER . . . Avon's own exclusive high frequency resistance welding method produces an entirely new uniformity of grain structure in the welded and adjacent wall area by means of an advanced type of electronic control. This exclusive process combined with our improved cold drawing of larger size tubing into smaller diameters is responsible for the extremely smooth surface finish, closer diameter tolerances and new ease of fabricating.

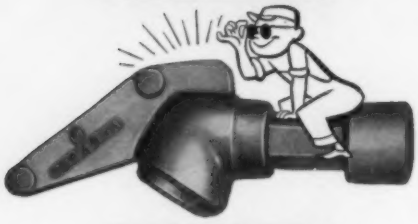
Fusionweld HAS A PERFECTED SINGLE WALL CONSTRUCTION . . . Avon is able to offer thin wall tubing as a highly impressive substitute for costlier tubing—both ferrous and non-ferrous—because of its hi-cycle method of controlled welding. This tubing is available in three tempers—"as welded," "as drawn" and annealed to insure the last word in adaptability to varied tubing uses. It is more economically fabricated—takes tougher bends, beads, flares, etc.—withstands pressures up to 18,000 PSI—has no equal in resisting the severest types of fatigue from vibration.

Fusionweld IS EASIER TO FABRICATE . . . Avon's exclusive tube making process has proved itself, matching the most difficult forming operations, with a higher degree of ductility and tensile strength to insure new fabricating ease, lower scrap loss, greater performance reliability. Today our mills are successfully producing over 7½ million feet per month for hundreds of important tubing applications. Our sales engineering staff will gladly assist you . . . or send us your blue prints for tube quotations.

⅛" O.D. to ¾" O.D.
PLAIN OR TERNE COATED

AVON TUBE DIVISION
HIGBIE MANUFACTURING CO.
ROCHESTER MICHIGAN





Clean, bright, accurate, strong — that's the story of Ritco Drop Forgings. We produce parts to your blueprint in steel or non-ferrous metals, in weights from ¼ lb. to 15 lbs.

Come to Ritco for Drop Forgings, special fasteners, and finished bolts with regular or heavy heads. Also, take advantage of our complete facilities for finishing — machining and grinding. Send blueprints and specifications for free estimates.

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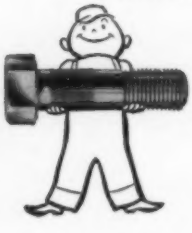


Exclusive New England Representatives for Cleveland Cap Screw Co.

for different methods of hose attachment—female pipe thread, male pipe thread, expansion ring or barb shank type. Eight standard sizes are provided from ¼ to 2-in., which are available in stock. Ten sizes from 2½ to 12 in. are available on special order.

Standard materials, unless otherwise specified, are cadmium-plated steel with neoprene and "Buna-N" seals. Couplings are available in aluminum, brass, stainless steel and other alloys on request. Special seal materials are also available on special order. Titeflex, Inc., 500 Frelinghuysen Ave., Newark 5, N. J.

For more information—
Circle 87, inside back cover

Die-Cut Thrust Washers

Custom-made washers for which tooling costs are said to be substantially lower are being made of materials such as bronze, bakelite, brass and any type of alloy sheet steel. They can be produced in sizes of ⅛ to 20, with maximum blanking pressure of 295 tons. Dayton Rogers Mfg. Co., Minneapolis 7, Minn.

For more information—
Circle 88, inside back cover

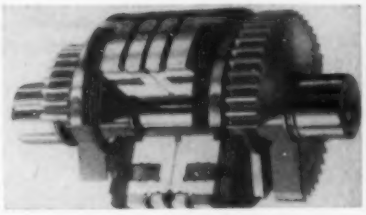
Subminiature Thermal Switch

A chemical-type thermal switch is ⅛ in. dia and ⅞ in. long. Below a predetermined switching temperature, resistance exceeds 10 megohms. When the unit reaches switching temperature, the resistance becomes permanently less than 0.10 ohm. Cur-

rent rating is 5 amp, ac or dc, continuous duty.

These switches are available at switching temperatures from 150 F to 400 F in increments of 25 deg, and from 400 F to 1000 F in increments of 50 deg. Accuracy is 2 percent. Minitec, 5423 Delaware Ave., Los Angeles 41, Calif.

For more information—
Circle 89, inside back cover



Electromagnetic Clutch for Mesh Gearing

This clutch, according to the maker, fits the requirements of transmissions employing constant mesh gearing, providing constant output, quiet operation and rapid speed change. Safe positive operation is assured because the clutch is controlled by a 24 v, d-c circuit and no field adjustment of the torque value of the clutch can be made. Maintenance is reduced to a minimum since the clutch is self compensating and no adjustment for wear of the clutch plates is ever required. I-T-E Circuit Breaker Co., Philadelphia, Pa.

For more information—
Circle 90, inside back cover

Hose Couplings With Built-In Check Valves

The basic coupling structure has been combined with either a single or double check valve, producing a type of coupling which shuts either one end (single-check valve) or both ends (double-check valve) of the fluid line the instant the coupling is opened. The check valves are automatically opened, permitting full fluid flow, the moment the coupling is closed.

Several types for different methods of hose attachment are made: female pipe thread, male pipe thread, expansion ring, or barb shank. All these

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BOTH HARD AND SOFT SOLDERS
Frenchtown's new single metallic coating on refractory ceramic bodies provides a surface to which solders with melting points from 275° F. to 1600° F. may be applied. No expensive, intermediate nickel and/or copper plating is needed to form a strong, firmly adhering bond with both hard and soft solders.
Now is the time to reexamine your requirements and specifications. Look to Frenchtown's new METALLIZED CERAMICS to save you production time and money. Phone or write for help on any problem involving the bonding of ceramics to metal parts or ceramics to ceramics.
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ONE COMPANY

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Producing this small Part by...

microcast

There were two ways to make this small indentor die for a ratchet-controlled Hytool (used to install coaxial cable connectors). First, by machining it from bar stock in 14 operations . . . or, by having the part Microcast, followed by 7 operations. The Microcast precision casting method was chosen because it saved an estimated 43% on the cost of each indentor die.

If the expense of machining intricate parts and components is throwing your production budget out of line, let us show you how the Microcast process can help you. Microcast can not only eliminate machining operations but it also allows you to engineer for better design through the use of high-heat alloys.

Write for free booklet. Full color talking film of the Microcast process available without charge.

MICROCAST PRECISION CASTINGS PROCESS

microcast

MICROCAST DIVISION, Austenal Laboratories, Inc.
224 E. 39th Street, New York 16, N. Y.
7001 South Chicago Avenue, Chicago 37, Ill.

The Original Process for Mass Producing Precision Investment Castings.

types are interchangeable in the same size. Eight standard sizes from ¼ to 2-in. are available from stock; ten sizes from 2½ to 12 in. are available on special order.

Standard materials, unless otherwise specified, are cadmium-plated steel with neoprene and "Buna-N" seals. Couplings are available in aluminum, brass, stainless steel and other alloys on request. Special seal materials are also available on special order. Titeflex, Inc., 500 Frelinghuysen Ave., Newark 5, N. J.

For more information—
Circle 91, inside back cover

Thermistors for Temperature Control

A thermistor designed specifically for temperature measurement and control in the −60 to 40 C range has a temperature-sensitive resistance element in the form of a thin toothpick-like rod with radial leads. It is made of metal oxides and manufactured by a ceramic process. All units are waterproofed and coated with reflective coating. Performance meets the requirements of military specification MIL-T-12284A (Sig. C.) Ferroxcube Corp. of America, 195 E. Bridge St., Saugerties, N. Y.

For more information—
Circle 92, inside back cover

Encapsulated Wire Wound Resistors

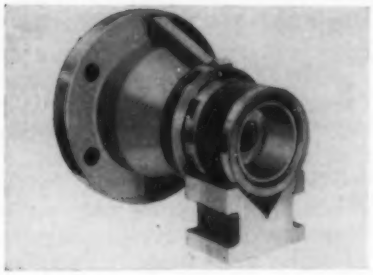
These resistors are said to be specifically designed to perform accurately in the face of extremes in humidity, high altitudes and corrosive conditions. At the same time they will withstand severe shock and vibration.

By winding on steatite bobbins, dimensional stability is assured. By

sealing in epoxy resin, they are protected against outside elements. They have, in many tests withstood 30 humidity cycles of MIL-R-93A moisture resistance tests without deterioration. Type L resistors also withstand temperature cycling in excess of MIL-R-93A requirements.

These components are furnished with lug type terminals or wire leads in a selection of standard, midget and sub-miniature sizes. Resistance Products Co., 714 Race St., Harrisburg, Pa.

For more information—
Circle 93, inside back cover



Increases Production and Accuracy of Hobbed Pinions

Taking advantage of the elasticity of metals to compress a solid inner shell evenly around the ground hub of a pinion, centering it precisely for hobbing, this fixture is reported to apply equal force all around the chucking surface. The operator twists the actuating ring a few turns to create an accurate and powerful fit. A special lever engages notches in the actuating ring and facilitates actuation and release.

Standard flange-type chucks of this new design are being made in 13 sizes, with chucking diameters from 0.500 to 4.0000 in.; maximum torque ratings from 37 to 2460-ft-lb. Scully-Jones and Co., 1901 S. Rockwell St., Chicago, Ill.

For more information—
Circle 94, inside back cover

Stainless Toggle Clamps

Toggle clamps made from non-magnetic stainless steel are available in a range of sizes and types. This new clamp has a channel on which the spindle can slide to permit its posi-

when your problem calls for a Governor.... call on
PIERCE
40 years specialization in the speed control field
Pierce Designs Make It Easy to Plan for Efficient Governor Installation: As shown in the above diagram there are a number of places on your engine where you can provide drive access for a Pierce Governor: Top, front or rear of timing gear . . . or at various locations connecting directly to camshaft. Pierce builds a wide variety of mounting types and drives . . . governor assemblies to cover every engine speed control problem.
Pierce Centrifugal Governors are in daily use for accurate, dependable engine speed control wherever wheels turn. More than 4,000 different governor assemblies have been designed and built by Pierce to meet exacting problems and applications encountered by engine builders. Pierce Governors are standard on many of America's finest engines.
tell us your problem...
We'll work with you on the engine controls you need . . . carburetor choking, constant speed control, overspeed protection, overspeed safety cut-off, fuel regulation or related requirements. Tell us your specific problems . . . we'll send a qualified engineer.
Ask for the new Pierce Brochure . . . "40 Years of Manufacturing Precision Controls."
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also built by PIERCE
SISSON Chokes
Automatic Carburetor Chokes, original equipment or replacement.
Aircraft Accessories
Overspeed Governors and Fuel Controls for turbo-jet engines.
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Hydraulic booster controls for heavy-duty vehicles and aircraft.

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● Like any other commodity, when you buy a standard resistance welder instead of a special, you save money and get shorter delivery.
Perhaps you have been thinking in terms of a "special" welder when a standard might do the job. T-W is a logical source because they make more standard spot, seam, flash-butt and projection welders than any other manufacturer, in addition to a wide variety of special welders.
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THE TAYLOR-WINFIELD CORPORATION • WARREN, OHIO

tioning anywhere along its length, to provide the exact placement of spindle on the work. The spindle, in turn, provides adjustment for height and for clamping force. The recommended force of this model is 400 lb with the spindle located at the end of the channel. Lapeer Mfg. Co., Lapeer, Mich.

For more information—
Circle 95, inside back cover

Self-Anchoring Locknut

A "T"-shaped nut, made of high grade steel and preassembled into a retaining cage, is said to be impossible to rotate or drive it out of its spring steel enclosure. The new fastener is placed in a panel hole by hand and pressed to locked, screw-receiving position with a simple hand tool. Welding, clinching or staking operations are unnecessary.

Designed to withstand excessive amounts of torque, the new nuts are recommended for applications where fasteners are in danger of being lost due to stacking, butting or rough handling of sub-assemblies on the production line. The new fastener can be attached after any finishing process, thereby eliminating retapping or masking. Tinnerman Products, Inc., Cleveland, Ohio.

For more information—
Circle 96, inside back cover

Nuts In Strip Form

Produced in coil or strip form with a partial shear between each nut for detachment, these fasteners are said to eliminate production line slowdowns due to dropped or misplaced parts.

Interchangeable for No. 6, 8, 10 and 14Z screws, the new nuts are available in coils or strips of any de-

The precise pitch of this wire helix, in its glass tube, is accurately measured by Hewlett-Packard Company, using a Kodak Contour Projector.

to make the difficult easy

...the easy economical

Using the same contour projector, Hewlett-Packard checks spacing and parallelism of this special tuning condenser.

Hewlett-Packard relies on the Kodak Contour Projector

Here is an on-the-job demonstration of how projection gaging can solve difficult problems in inspection, slash costs in checking parts to close tolerances.

Using a Kodak Contour Projector, Hewlett-Packard Company measures the pitch of a precision wire helix for a unique electronic tube. Surface and shadow illumination provide a 20× enlarged image of the minute and delicate part. "Without the Kodak Contour Projector," say Hewlett-Packard officials, "it would not be practical to make the measurements necessary to get a satisfactory instrument."

Using the same contour projector, Hewlett-Packard also checks spacing and parallelism of a special tuning condenser for electronic test equipment. Conventional shadow projection provides a 10× enlarged image of the leaves. "Use of the projector," the company reports, "permits economical measurements of parallelism to an accuracy impossible to obtain by other methods."

Diverse jobs like this are easily done with a Kodak Contour Projector. A twist of a dial provides whatever magnification is needed. A flick of a switch brings surface illumination to supplement shadow projection. Easy to see, isn't it, how a Kodak Contour Projector quickly pays for itself in use.

For more information on how you can use projection gaging in your own work, send for a free copy of "Kodak Contour Projectors."

EASTMAN KODAK COMPANY
Special Products Sales Division
Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

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TRADE-MARK

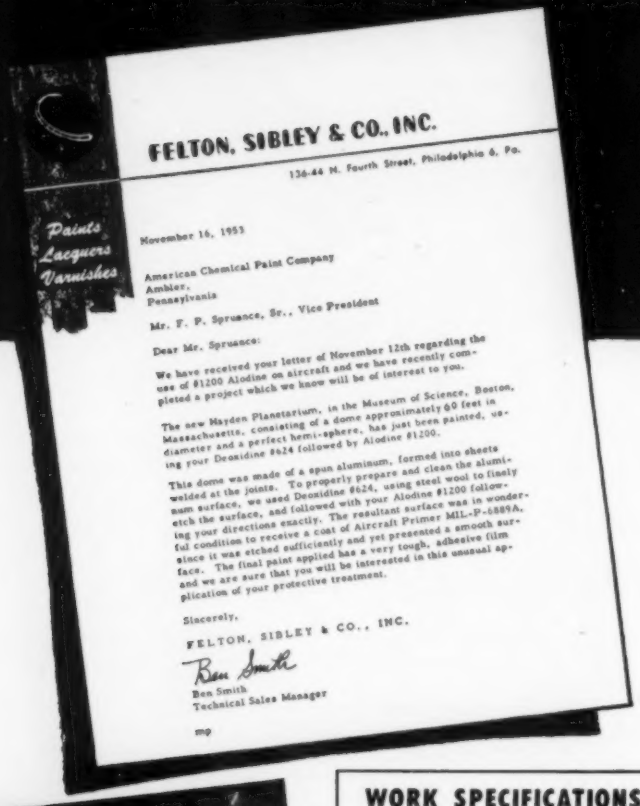
NEW HAYDEN PLANETARIUM

(Museum of Science • Boston)

Alodized

with "Alodine" No. 1200

FOR EXTRA PROTECTION



FELTON, SIBLEY & CO., INC.

136-44 N. Fourth Street, Philadelphia 6, Pa.

Paints Lacquers Varnishes

November 16, 1953

American Chemical Paint Company
Ambler,
Pennsylvania

Mr. F. P. Sprunce, Sr., Vice President

Dear Mr. Sprunce:

We have received your letter of November 12th regarding the use of #1200 Alodine on aircraft and we have recently completed a project which we know will be of interest to you.

The new Hayden Planetarium, in the Museum of Science, Boston, Massachusetts, consisting of a dome approximately 60 feet in diameter and a perfect hemi-sphere, has just been painted, using your Deoxidine #624 followed by Alodine #1200.

This dome was made of a spun aluminum, formed into sheets welded at the joints. To properly prepare and clean the aluminum surface, we used Deoxidine #624, using steel wool to finely etch the surface, and followed with your Alodine #1200 following your directions exactly. The resultant surface was in wonderful condition to receive a coat of Aircraft Primer MIL-P-6889A, since it was etched sufficiently and yet presented a smooth surface. The final paint applied has a very tough, adhesive film and we are sure that you will be interested in this unusual application of your protective treatment.

Sincerely,

FELTON, SIBLEY & CO., INC.

Ben Smith

Ben Smith
Technical Sales Manager

mp

BEFORE

AFTER

WORK SPECIFICATIONS	
AREA TREATED	Aluminum dome
PRE-TREATMENT	"Alodine" No. 1200, applied by brush
PAINT	Felton Sibley DOME-LAC No. 20
CONTRACTOR	H. Newton Marshall Company, Inc., Boston, Mass.

Write for booklet

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General Offices: Ambler, Penna.

Detroit, Michigan *Niles, California* *Windsor, Ontario*

sired lengths. They are designed for power-driven attachment with type A or B (Z) sheet metal screws. These fasteners are also easy to hold and they provide locking, vibration-free attachment. Slight hand pressure snaps the secured nut from the strip. Tinnerman Products, Inc., Cleveland, Ohio.

For more information—
Circle 97, inside back cover

Capacitive Pressure Pickups

These capacitive pressure pickups are reported to be capable of performing satisfactorily at temperatures up to 6000 F, in highly corrosive atmospheres and with the broadest range of measurement parameters.

Pressure range is from 1 to 75,000 psi. Outputs are as high as 15 v with a 25,000 ohm load. Frequency response is from 0 to 10,000 cps. Unit is made of stainless steel with glass-to-metal seals. Photocon Research Products, 421 N. Foothill Rd., Pasadena 8, Calif.

For more information—
Circle 98, inside back cover

Stainless Steel Discharge Valve

This stainless steel valve, a flange type, was developed for use on truck tanks and is said to eliminate the possibility of a truck's valve being damaged. The loss of the tank load, as sometimes happens with external valves when the truck is involved in a collision or mishap, is no longer possible. Interior flush mounting of the valve also prevents clogging of the

lines caused by congealing liquids. Heating the outlet before unloading is no longer required. Extra-heavy threads elevate the valve plug from its $3\frac{3}{8}$-in. opening. Four large discharge ports always permit the liquid being unloaded to flow freely from the tank. Chem-Valve Corp., 110 Berkshire Valley Road, Kenvil, N. J.

For more information—
Circle 99, inside back cover

Miniature Clutch Has Nine Parts

This miniature is said to do the job of a clutch two or three times its bulk at low cost, with only nine parts. It handles loads up to 2 hp and 2500 rpm. There are other models that can handle loads up to 600 hp.

Some of the uses of this clutch are multiple-speed, geared-power transmission (power lawn mowers, outboard motors, tractors, motorcycles, automobiles or any specialized equipment that needs power transmission), reversing mechanisms (marine), tapping attachments, line shaft applications, power steering on automobiles, shop equipment. It is easily adapted to any operation using belt or chain drive.

The clutch operates in either direction, and will free-wheel in cases where the load continues to coast after the power has been stopped. Christensen Clutch Corp., 306 Dixon St., Compton, Calif.

For more information—
Circle 100, inside back cover

Split Hydraulic Transmissions

Components of these split hydraulic transmissions are standard units selected to meet the operational requirements of such textile machinery as slashers, pickers, dye becks and continuous washers. Pump, motor and appropriate valving are combined to provide an efficient positive displacement type fluid power transmission having infinitely variable speed control. Both the pump and the hydraulic motor have controls for regulation of output speed and power characteristics. Acceleration and deceleration

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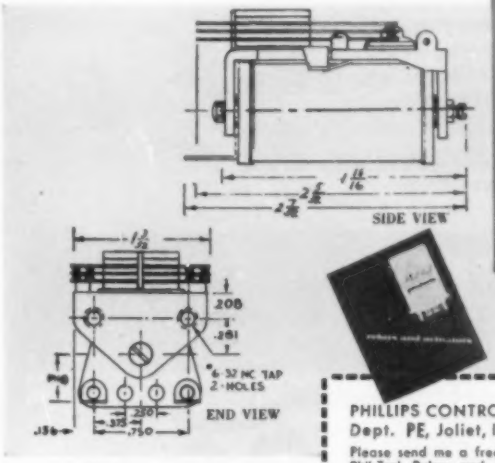
...another addition to the many types of Phil-trol Relays...

Rugged dependability plus high sensitivity have made this new Phil-trol relay an immediate favorite with engineers and designers. Its compactness and adaptability to a wide range of applications and uses provide new answers to the many complex problems confronting electronic and control engineers.

Unusual features of the new 8QA relay include immediate response; fast closing and opening; contact springs with twin contacts; heavy duty, long-life bronze bearings; light weight.

Like all standard Phil-trol relays, the 8QA is available in a wide range of modifications. Coils may be single or double wound, and equipped with copper slugs or sleeves for slow release or for slow operation.

In all probability, there is a standard Phil-trol relay, or variation, to meet your specific need. Phil-trol engineering experience and design facilities are available to help you solve any new application problem.



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QUARTER-TURN FASTENERS

MEAN QUICK ACCESS. On panels, doors or covers, Camloc Fasteners provide positive locking by a quarter-turn with a screw driver or wing head. They're vibration-proof, because the action of cam, spring and detent creates a uniform locking torque that grips firmly. Camloc Quarter-Turn Fasteners cost less to install... minimize replacement... fewer do the job.

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SAFELY AND EASILY OPERATED. Where high shear-tension capacity is a factor... where opening and closing must be done under heavy loads—Camloc has the answer. Spring-loaded handle, retracting sheer pin, positive locking are among the many design advantages.

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SUITED TO YOUR NEEDS. In the electronics, aircraft, machinery and many other fields, leading original equipment manufacturers are calling on Camloc's Engineering Department to design special fasteners that increase accessibility.

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A complete departure from conventional fastening.
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rates are independently adjustable. The simple-to-operate controls are easily installed. Existing push-button stations can usually be modified and used.

Split transmissions are particularly useful where special placement of the hydraulic equipment is desirable, such as separation of hydraulic pump and hydraulic motor to meet space limitations or solve alignment problems. They offer particular advantages where drive requirements demand special combinations of a pump and more than one hydraulic motor.

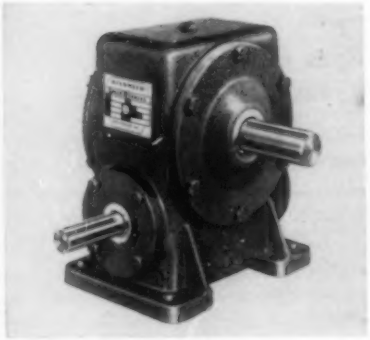
Standard a-c electric motors are used with these hydraulic transmissions, since input speeds are constant. The slasher drive requires only 7½ hp at 1200 rpm for a production rate of 80 yards per min. Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich.

For more information—
Circle 101, inside back cover

Grounding Locknuts

A washer-type locknut with tooth-like elements in the flanged base digs through non-conducting materials to achieve an electrically grounded assembly. A double-locking spring action is said to be exerted on the screw threads as the teeth of the washer embed themselves. The new fastener is available in No. 10-24 and ¼-20 sizes. Palnut Co., 61 Cordier St., Irvington 11, N. J.

For more information—
Circle 102, inside back cover



Speed Reducers for Minimum Space

The first five sizes of a new line of worm gear speed reducers are within

the 1/100 to 5 hp range, in ratios of 5:1 to 60:1. The balance of the line, involving eight other sizes, are already designed.

Fulfilling all American Gear Manufacturing Association standards, the new speed reducers are equipped with gears, bearings and shafts rated for AGMA Class 1 Service. Housings are of one-piece construction and are reinforced to assure secure mounting for smooth, vibrationless operation.

Although these new reducers have been compactly designed to meet minimum space requirements, surface area is said to provide ample heat-radiating capacity. Winsmith, Inc., Springville, N. Y.

For more information—
Circle 103, inside back cover

Secures Tubing Clamps

Designed to fasten aircraft tubing, this nut features rounded corners and turned-down ends which bear against the upper leg of the tube clamp to eliminate any possibility of the fastener rotating after assembly. It also eliminates the danger of sharp corners extending beyond the width of the clamp.

After the clamp is placed over tubing or a wire bundle, the nut is merely positioned over the mounting hole and secured with an AN 530-8 or 530-10 screw. The fastener can be applied to any ½-in. wide flange with a minimum thickness of $\frac{1}{16}$ in. Tinnerman Products, Inc., Cleveland, Ohio.

For more information—
Circle 104, inside back cover

Restarts Motors Automatically

Whenever motor starters disconnect because of low voltage or voltage failure, interruptions occur in electrical service that reduce productivity and impair efficient processing. To minimize effects of low voltage disconnections, a new time delay push-button condulet restarts motors automatically. The device can be set to restart motors within time limits of 2, 4 or 6 sec.

Designed for use at hazardous locations of Class I, Group D; Class II,

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HAYDON makes very small, extremely rugged Timing Motors for 60 cycle, 400 cycle, and d-c use. They precisely, dependably measure and control timing — under variable conditions . . . in unusual locations and positions . . . without taking up too much space! With the help of HAYDON Timing Motors, you can now build time controls into your product with a minimum increase in space requirements!
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Shaving newspaper plates ...quickly, accurately

Hammond Plate Shavers use

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Shaving 19" x 26" newspaper plates to correct printing height within 12 seconds . . . shaving 30 to 40 thumb nail shell plates at one time with uniform accuracy, this Hammond Model S-8 Plate Shaver is equipped to help a newspaper go to press before deadline.

Directly coupled to a 1½ HP motor in the drive mechanism, which moves the plates into the carbide blade, is a Winsmith Model 11H Differential Speed Reducer with a reduction ratio of 108:1. Correct speed for fast, smooth and accurate shaving is assured.

Compactness, ruggedness and dependability have made Winsmith reducers most preferred for applications within the 1/100 to 85 HP range, in ratios of 1.1:1 to 50,000:1. Why not find out how this complete line of differential, worm gear, helical gear and worm-helical reducers can meet your needs to best advantage?

For details, request Catalog 148 . . . and for information on Winsmith's new "C" Line Worm Gear Speed Reducers, request Bulletin HW654.

WINSMITH, INC.
111 Eaton St.
SPRINGVILLE (Erie County), N. Y.

WINSMITH SPEED REDUCERS

MEMBER OF AGMA

Groups E, F, and G, or Class III, interior electrical equipment of the new device includes a push-button switch, capacitor, rectifier, sensitive relay and control relay. In addition, a transformer for voltages exceeding 110 is supplied, with capacities of 220, 440 and 550 v. All internal wiring is supplied, including two terminal blocks: one for field connections and another marked for 2, 4, and 6 sec. Crouse-Hinds Co., Wolf and N. 7 St., Syracuse, N. Y.

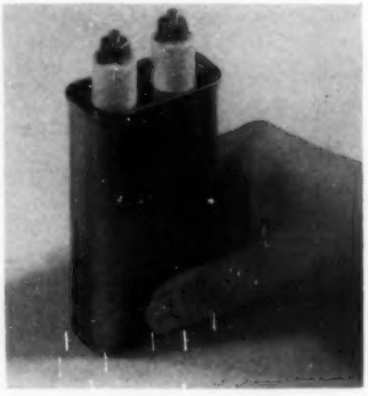
For more information—
Circle 105, inside back cover

Titanium Rivets

These rivets are manufactured from C-130AM titanium alloy and provide a 40 percent weight saving over the same rivets in alloy steel. Yet they have a minimum shear strength of 95,000 psi. No protective finish or lubrication is said to be necessary.

Titanium rivets of this type also retain useful strength at elevated temperatures, from 800 to 1800 F. The manufacturer can now supply titanium rivets in the same types and sizes as alloy steel rivets being furnished to HS, NAS or customer specifications. Pheoll Mfg. Co., 5720 W. Roosevelt Road, Chicago 50, Ill.

For more information—
Circle 106, inside back cover



Fixed Paper-Dielectric Capacitors

Drawn rectangular cases eliminate soldered seams in these fixed paper-dielectric capacitors. Designed for motor, industrial control, filter, lu-

minous-tube transformer, and other a-c or d-c applications, these new units have the same base area as those in fabricated cases and are interchangeable with them.

Use of solder has been eliminated in the construction of the new cases through double-roll seaming around the top. Since the bottom of the cans are indented, the new units can be mounted in an inverted position, as well as upright.

The new units will be available in capacitance ratings of 0.05 to 16 mf and voltage ratings of 400 to 12,500 v, dc, and 236 to 660 v, ac. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 107, inside back cover

Production Quantities of Titanium Fasteners

Titanium alloy RC 130B, in which production quantities of fasteners are now being made, is a special wire composed of 92 percent titanium, 4 percent aluminum and 4 percent manganese. Parts of this material can have tensile strengths of 150,000 psi, min, and shear strengths of 95,000 psi min. This metal can withstand temperatures up to 800 F.

This titanium alloy RC 130B weighs approximately 44 percent less than alloy steels of corresponding strength. This material has withstood 250 hr of salt spray without evidence of corrosion.

Further information on the availability of standard and special titanium fasteners can be obtained from Camcar Screw & Mfg. Corp., 629 Eighteenth Ave., Rockford, Ill.

For more information—
Circle 108, inside back cover

Right-Angle Terminal Strip For Printed or Etched Circuits

Fifteen 0.040-in. dia terminals are provided in these right-angle strips although omission of certain terminals can be arranged. Nominal creep is $\frac{3}{32}$-in. Pins are phosphor bronze, with plating of gold over silver. Terminals extend through $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{1}{4}$-in. card thicknesses. Terminal strips for com-

To be sure you're getting top quality lightweight castings, you'll want to look for:

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ARMCO 17-4-PH
4750
AISI 300 SERIES
AISI 400 SERIES
*MONEL
*INCONEL
ACI-H7
18-4-1
IIB2
IID2
INVAR
CO-CR-W ALLOYS
CU-NI ALLOYS
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NI-FE ALLOYS
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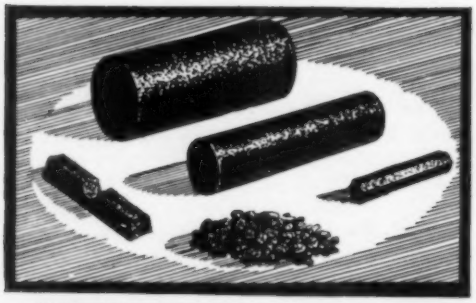
A *long* alloy list is an excellent indication of long alloy experience! As source for many of the nation's major investment casting suppliers and others, Cannon-Muskegon furnishes a great variety of alloys for remelt or reprocessing. Alloys include super stainless and tool steels, as well as nickel and cobalt-base alloys. Other alloys are prepared specially for medical, aeronautical, electronic, industrial and experimental uses.

These alloys are in addition to a wide range of carbon and 300 and 400 series stainless steels regularly carried in stock for *immediate* delivery. Remember . . . no matter what type alloy you specify each is backed with a notarized metal analysis insuring *exactly predictable* physical, chemical and electrical properties.



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bination card thicknesses can be supplied. Also, strips can be mounted end-to-end for cards requiring additional terminals.

Material is standard green mineral-filled phenolic. The strips are also available in mineral-filled phenolic Type MFE, diallyl phtalate MDG, or general purpose phenolic CFG. H. H. Buggie, Inc., 726 Stanton St., Toledo 4, Ohio.

For more information—
Circle 109, inside back cover

Valves For Air-Conditioning Equipment

Two thermostatic expansion valves with selective orifice capacity cover a range of from 0.7 to 3½ ton capacity. The smaller valve is rated basically at 2 ton capacity, while the larger is a 3½-ton capacity unit.

The valves are of a self-centering ball seat type and have a built-in liquid line strainer plus low friction-type action. General Controls Co., 801 Allen Ave., Glendale, Calif.

For more information—
Circle 110, inside back cover

Blower Wheel Has Only Eight Parts

A blower wheel has been developed for heating and air conditioning equipment which is composed of only two stamped strips of blade louvers, two center discs, two hubs and two setscrews. This blower is said to produce higher pressure at the same speed as other wheels or equal pressure when run at lower speeds. Mayne Products Co., 324 Harries Building, Dayton 2, Ohio.

For more information—
Circle 111, inside back cover

Stationary Batteries for Auxiliary Power

Stationary batteries for use in switchgear, control, and auxiliary power applications are made in two complete lines, in various capacities from 10 to 770 amp-hr. Designed for full-float operation where a life expectancy of 14 yr in float service normally

applies, proportionately long life also is reported for the "Plasticell" battery when used in trickle charge service.

Lead calcium grids, used in the "Plastical", (in sizes from 40 to 770 amp hr) embody engineering characteristics projected on a life expectancy of 25 yr in full-float service. Water additions are said to have been reduced to ¼ to ⅛ as many as that required for conventional batteries. C & D Batteries, Inc., Conshohocken, Pa.

For more information—
Circle 112, inside back cover

Gage Measures Holes of 0.020 to 0.130 in.

This direct-reading hole gage is guaranteed accurate to within 0.0005 in. over its entire range. The new instrument is similar in appearance and operation to a ball-point pen or automatic pencil. The scale is graduated in thousandths and has a built-in 2½X crystal magnifier which enables the user to readily obtain accurate readings to the nearest half-thousandth. U. S. Expansion Bolt Co., York, Pa.

For more information—
Circle 113, inside back cover

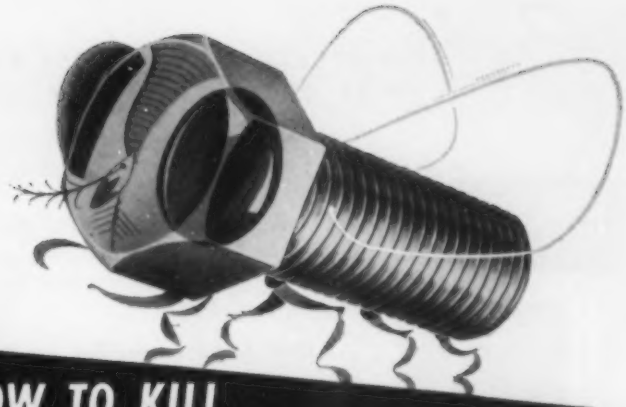
Hook-On Volt-Ammeter

A wide range, pocket volt-ammeter for measuring alternating current and voltage quickly and accurately measures 9⅛ by 3-7/16 by 1-9/16 in. It includes 150/300/750 v, ac, as its volt ranges.

Said to be capable of measuring current on both insulated and non-insulated conductors without cutting the conductor or interrupting work, the new volt-ammeter is equipped with scales that automatically change when the range selector knob is turned, thus reducing the possibility of reading a wrong scale.

Current of 10/30/100/300/800 amp, ac, provides for the measurement of currents usually encountered in industrial or commercial circuits. In addition to the wide choice of ranges, a pointer stop mechanism has been incorporated.

In measuring voltage the screw-in safety voltage leads are connected into recessed terminals for the protection



HOW TO KILL
5 thread fastening bugs in design...

Been Stung BY TOO MUCH WEIGHT? ***Heli-Coil**** Inserts permit weight reduction two ways: They require less space than solid bushings. Need no greater boss radius than unprotected thread assemblies. Permit the use of fewer, smaller, shorter threaded fasteners.

Been Stung BY WEAK THREADS? ***Heli-Coil*** Inserts provide a minimum of 25% greater loading strength than unprotected threads in the same material. You eliminate stripping, even in soft materials such as aluminum, magnesium, plastics, wood, etc.

Been Stung BY THREAD WEAR? ***Heli-Coil*** Inserts can't wear — therefore no customer complaints about worn threads; field service costs are cut.

Been Stung BY CORROSION? ***Heli-Coil*** Inserts are corrosion-proof stainless steel or phosphor bronze. They withstand temperatures up to 800°F. indefinitely — won't seize, gall or corrode.

Been Stung BY VIBRATION? Vibration will not loosen ***Heli-Coil*** Inserts; will not damage insert-protected threads. Fits are inherently better; stresses are more evenly distributed.

When you use *Heli-Coil* Screw Thread Inserts you kill *all five* of these design bugs *at once*.

To find out ***why*** the ***Heli-Coil*** Insert method of thread protection is the simplest, most effective, and most practical . . . to get all the data you need to design these advantages into your product . . . to get free samples of ***Heli-Coil*** Inserts, use this handy coupon.

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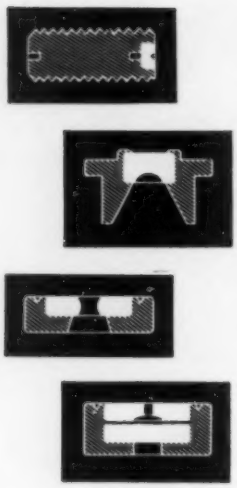

You'll be time and money ahead if you specify Bird complete jewel assemblies for your product. Rejects are eliminated, jewel breakage is minimized, and Bird jewel assemblies will keep your production running smoothly.

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Practically non-breakable, Durakool **Factory Set Timer Relays** have more than proved themselves on the roughest and toughest jobs that could be found. Year by year, their use increases in sensational fashion.

Controlled time available from .15 to 20.0 seconds in either normally open or normally closed actions. No waiting. Your production schedule is met.

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★ No false contacts
★ No chatter
★ Quiet in operation
★ Low in cost

Durakool ALL-STEEL MERCURY Timers

of the operator. Then the desired voltage range and scale is selected by turning the selector knob.

Uses include checking circuits, motor overloads, and determining motor starting and running currents. The new volt-ammeter operates on the frequency of 60 cycles with a 3 percent full scale accuracy. General Electric Co., Schenectady 5, N. Y.

For more information— Circle 114, inside back cover

Low Capacity Strain Gages

Five new SR-4 load cells of low capacity extend the capacity range of standard cells down to 0 to 50 lb. Three Type U-1 load cells, designed for loading either in tension or compression, have capacities of 0 to 50, 0 to 100, and 0 to 200 lb. Two Type T-1 cells, designed for tension loads only, have ranges of 0 to 100 and 0 to 200 lb.

These cells are operated on either ac or dc at 4 to 8 v. Input resistance is 120 ohms. Their calibrated accuracy is within ¼ percent of full range. Hermetically sealed containers protect the load sensitive elements.

Type U-1 cells are 4 in. dia, 5¾ in. high and weigh 10 lb. Type T-1 cells are 2⅛ in. in dia, 3½ in. high and weigh 2 lb. Baldwin-Lima-Hamilton, Philadelphia 42, Pa.

For more information— Circle 115, inside back cover

Filing Systems for Large Drawings

A device to facilitate the filing of large tracings, layouts or prints so as to make them readily accessible consists of a rack with a number of parallel tracks, from which the drawings are suspended by means of roll hangers. The rack being twice the length of the sheets it holds, the one desired can be quickly rolled from its filing place to the other end of the rack where it is out in full view.

The rack can be built to accommodate any specified number of tracks, which are spaced 1 in. or more apart to provide ample room for layouts made not only on thin metal

plates but also on thicker materials. The rack may be of any length required by the size of the layouts and may be either attached to the wall or mounted on caster-equipped standards so that it may be moved from place to place. The wall model is fluorescent lighted. Inter Lakes Engineering Co., 4845 Bellevue Ave., Detroit 7, Mich.

For more information—
Circle 116, inside back cover

Completely Insulated Alligator Clips

This newly developed insulator fits skin-tight down to the tip of a miniature, 15/64" OD test clip. Dozens of these clips, it is asserted, can be closely compacted on crowded connections, in the tightest spots and at all angles, with complete protection against shorts and shocks. The new insulated alligator clip is available only as a unit, with factory-applied insulators. Two clip types are available in the new, completely insulated design. One is cadmium-plated steel, the other is solid copper with a brass screw connection. Each type is available with either red or black insulators for easy "hot" or "cold" lead identification. Mueller Electric Co., 1552 W. E 31st., Cleveland 14, Ohio

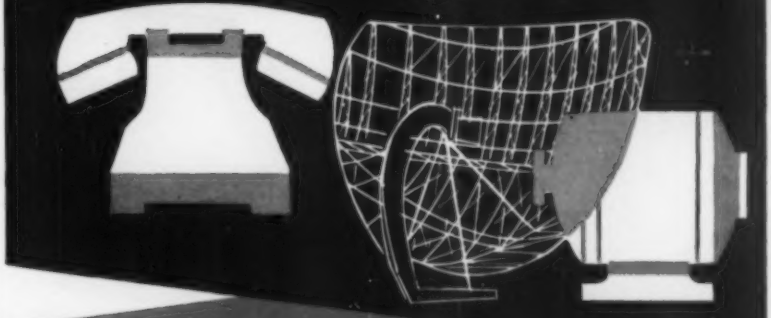
For more information—
Circle 117, inside back cover

Single Knob Process Timer

This unit will control the timed simultaneous closing of one electric circuit and opening of another. Industrial applications for the new proces timer include molding presses, machine tools and automatic mixing operations; in addition, power distribution equipment frequently requires precision control for starting automatic sub-station equipment, and for the reclosing of automatic circuit breakers.

Ideal for equipment which requires easily adjustable and accurately timed operations from an initial impulse, the TSA-21 includes one set of time-opening main contacts and one set of electrically separate time-closing main contacts. The trip point of the main contacts can be adjusted by an ex-

a special message for producers of electrical equipment



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Here's peak corrosion protection combined with conductivity, weldability and solderability. Here's a finish that holds paint firmly, prevents underfilm corrosion. Here's a line of attractive final finishes to add quality and sales-appeal. Here's Iridite . . . and here's how you can use it:

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER . . . Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

ON ALUMINUM Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

ON MAGNESIUM Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
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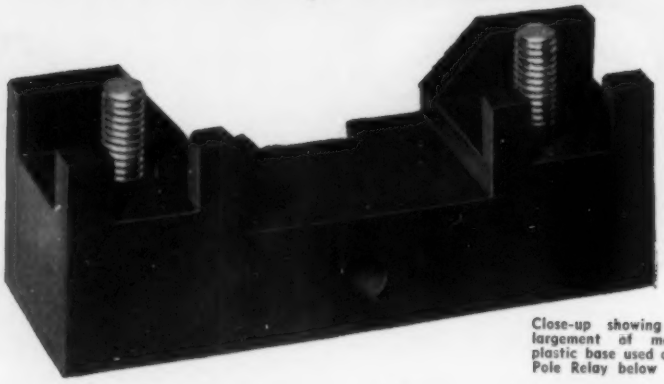
Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals, ASP Plating Chemicals.
WEST COAST LICENSEE: L. H. Butcher Co.

KUHN & JACOB
molds this plastic base

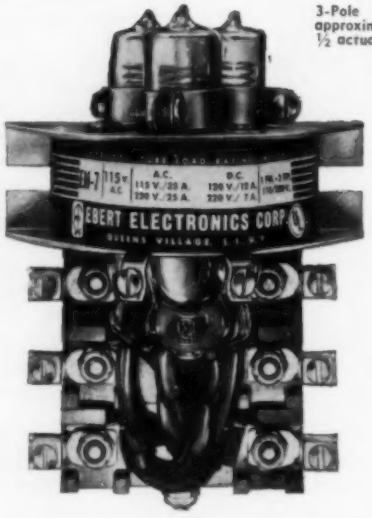


Close-up showing enlargement of molded plastic base used on 3-Pole Relay below

for Ebert Mercury Plunger Relays

SHOWN BELOW, MADE BY

EBERT ELECTRONICS CORP.
QUEENS VILLAGE, N. Y.



3-Pole Relay approximately ½ actual size

Accurately made to exact specifications, the Plastic Base shown above with inserts molded in is one of the reasons for the superior quality of Ebert Relays, which are reported to give millions of trouble-free operations. At K & J., designing, mold-making and molding are all so well interrelated that the end product is certain to give complete satisfaction at all times.

A recent change in design of the plastic base makes for greater ease of installation. K & J works closely with the customer in developing and improving the product for increased sales appeal.

Let us Quote on YOUR Requirements

KUHN & JACOB MOLDING & TOOL CO.
1230 SOUTHARD ST., TRENTON, N. J.

CONTACT THE K & J REPRESENTATIVE NEAREST YOU

S. C. Ullman, 55 W. 42nd St., New York, N. Y.
Telephone—Penn. 6-0346
Wm. T. Wyler, Box 126, Stratford, Conn.
Telephone—Bridgeport 7-4293
Wm. A. Chalverus, Carson Road, Princeton, N. J.

ternal knob. Also, each timer has a set of instantaneous contacts which can be used independently or as hold contacts for the timer solenoid, the engineers said.

The time scale is calibrated from 0 to 100 percent. Weight is 6¾ lb, measurements are 5¾ x 5¾ x 8$\frac{5}{32}$ in. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 118, inside back cover

Fully Automatic Whiteprinter

With an automatic tracing separation feature, this printer developer is synchronized to a maximum of 40 fpm.

As its light source the new whiteprinter is equipped with a 4000 w high pressure mercury vapor lamp, controlled by a constant wattage transformer. Front and rear print delivery is included at no additional cost. Full strength 26 deg Baume (commercial type) ammonia is used for developing.

The unit is designed with a short paper travel through printer and developer. For example, at 40 fpm, an 8½x11-in. tracing is returned to the operator in 2½ sec after feeding, and the finished whiteprint is delivered in 6½ sec. C. F. Pease Co., 3816 N. Rockwell St., Chicago 18, Ill.

For more information—
Circle 119, inside back cover

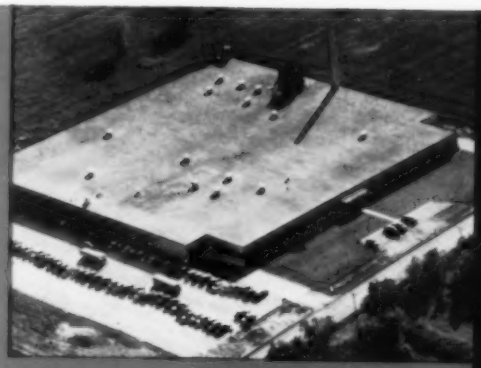
Oil-Burner Ignition Transformer

A choice of three heavy-duty base plates adapts this transformer to the majority of domestic applications. Equipped with high-voltage bushings mounted on either the bottom or the end of the unit, the transformer contains an electromagnetic shield, in addition to electrostatic shielding, for maximum suppression of radio and television interference. The bushings are of the plug type with male rajah base studs. Where other high-voltage connections are required, spring-clip and thumb-screw terminal adapters are available.

Designed for continuous or intermittent domestic duty on 60-cycle

modern new OHMITE® plant

Skokie, Illinois
(Suburb of Chicago)



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FACILITIES for
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of the FINEST in . . .

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Resistors

Tap Switches

modern
new
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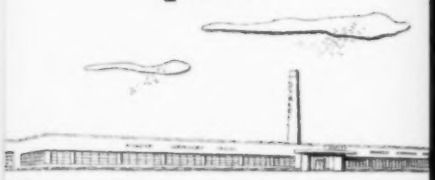


Fast Shipment from Stock

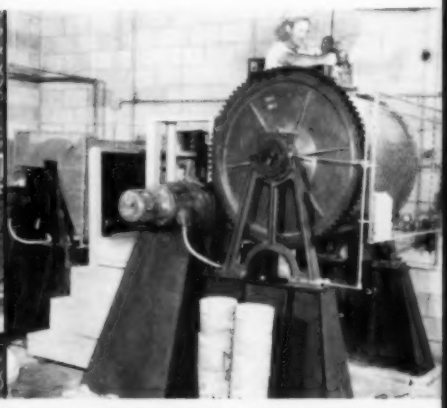
Ohmite maintains the world's largest stock of wire-wound rheostats and resistors for immediate shipment.

Incoming Inspection

Incoming materials are carefully checked against rigid specifications. Below, metal sample is being checked on Rockwell Hardness Tester.

Vitreous Enamel Production

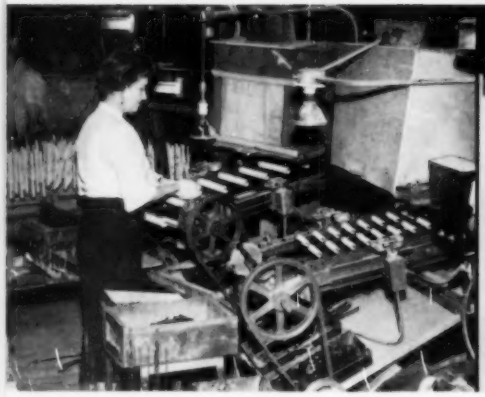
To get the properties needed, Ohmite found it necessary to develop and make its own exclusive enamels. Ball mill, below, pulverizes ingredients.



advanced
PRODUCTION FACILITIES

Several months ago, Ohmite Manufacturing Company moved to its modern new plant in Skokie, Illinois—a north suburb of Chicago. This new plant has provided Ohmite with the greatly increased facilities needed to meet its continuously expanding sales volume.

The new Ohmite factory and offices—covering an area of 128,000 square feet—are completely air conditioned. The plant contains the very latest in equipment and facilities—for efficient production of quality resistance and other electrical control products.

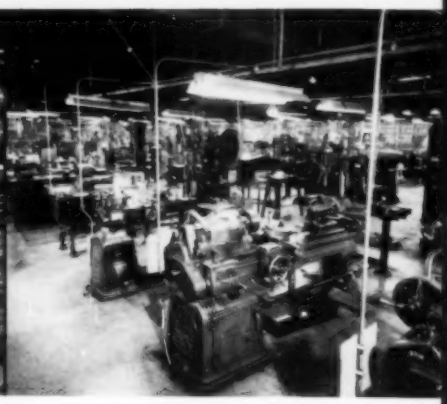


Resistor Firing

Modern, continuous, conveyor-type furnaces rotate resistors being fired. This prevents "pile-up" of the vitreous enamel . . . assures a uniform coating.

Rheostat Firing

Gradual heating and cooling in this continuous, rotary-type furnace provides a superior coating of vitreous enamel and prevents internal cracking.



Tool and Die Shop

Ohmite designs and builds most of its own tools, dies, gauges, fixtures and special machines in the well-equipped machine shop shown above.

Precision Resistor Testing

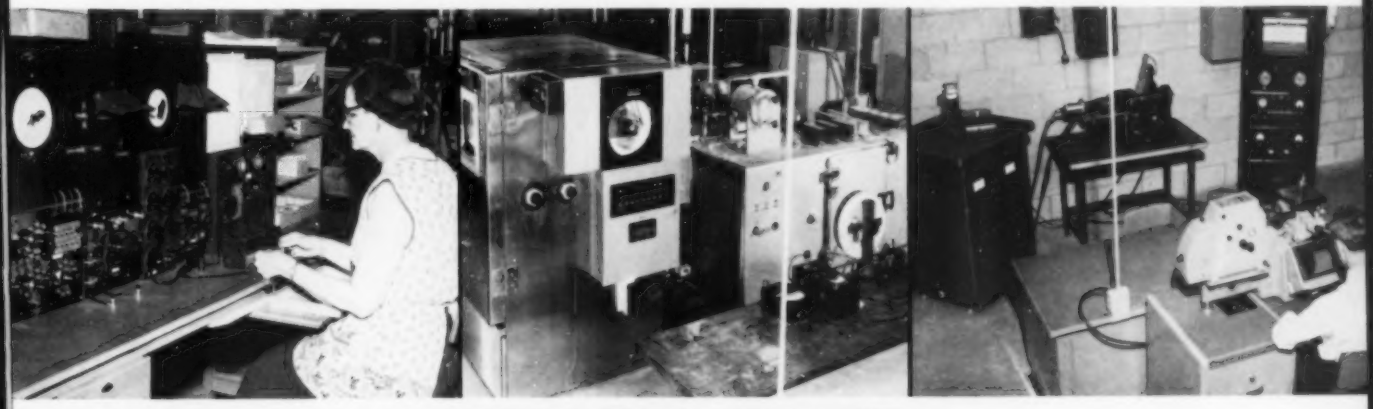
Each resistor is given a voltage breakdown test and the resistance value is measured. Ohmite resistors can be made to tolerances as low as 0.1%.

Humidity Chambers

In this equipment, using program-controlled cycles, Ohmite products are tested under a wide range of temperature and humidity conditions.

X-ray Diffractometer
and X-ray Fluorescence Spectrometer

These instruments make possible the determination of crystal structure as well as elemental composition of materials and products by means of x-rays.



advanced
RESEARCH AND TESTING LABORATORIES

The new Ohmite research, development, and testing laboratories use the finest scientific instruments and equipment. Here Ohmite products are tested and retested under the most grueling conditions to detect potential sources of trouble. And these same laboratories are used for the development of new materials, new processes, and new designs—to build Ohmite products that set new standards of long life and trouble-free performance.

Metallographic Laboratory

Special equipment is available for microscopic analysis of structure using metallograph. Thermal expansion of ceramics and vitreous enamels can be determined with interferometer equipment.

OHMITE®
MANUFACTURING COMPANY
3611 Howard Street, Skokie, Illinois
(Suburb of Chicago)

Testing Resistance Values

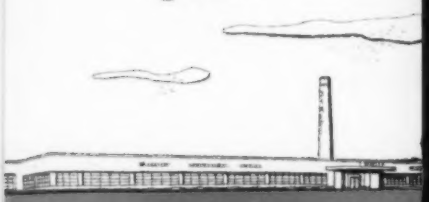
Resistors from the production lines are checked for continuity resistance value and tolerance. Standard Ohmite tolerance is ±5% where number of turns and alloy permit.

Microscopic and Petrographic Equipment

The Ohmite laboratories contain this equipment for the optical examination of materials and products.

RHEOSTATS
RESISTORS
TAP SWITCHES

modern
new
OHMITE
plant



1st FIRST
in
resistance
products

Standardization Laboratory

The instruments shown here are used to check and standardize the many pieces of Ohmite electrical test equipment.

Power Panel

This power panel provides AC or DC in a wide range of currents, voltages and frequencies—permits testing Ohmite products under operating conditions.

Vacuum Chambers

Vacuum chambers of this type are used to deposit an extremely thin film or coating of evaporated metal.

Special Purpose Furnaces

High temperature globar furnace; muffle furnace for enamel testing; hydrogen atmosphere sintering furnace.

OHMITE®
MANUFACTURING COMPANY

3611 Howard Street, Skokie, Illinois
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RHEOSTATS
RESISTORS
TAP SWITCHES

Write on Company Letterhead for Catalog and Engineering Manual.

circuits, the new transformer is rated at 100-120 v primary, 10,000 v secondary, 0.250 kva, with a secondary short circuit current of 23 ma. Net weight of the unit is 9½ lb. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 120, inside back cover.

Check Valve With Composition Sleeve

A check valve that provides maximum flow with low opening pressures and bubble-tight operation throughout its working range consists of a two-piece metal body and a special composition sleeve. The valve has no seat and no spring or other metallic moving parts. The sleeve is easily replaced if desired. The valve may be mounted in any position. It remains tight even when small amounts of foreign matter are present. The new check valve is available in a selection of sizes and materials. Betts Machine Co., Warren, Pa.

For more information—
Circle 121, inside back cover.

High-Temperature Miniature Capacitor

Tubular, hermetically sealed capacitors designed for continuous operation from −65 to 165 C have insulation resistance of 50,000 megohm-microfarads min at 25 C, 100 megohm-microfarads min at 125 C and 20 megohm-microfarads min at 165 C. Gudeman Co., 340 W. Huron St., Chicago 10, Ill.

For more information—
Circle 122, inside back cover.

Dc Magnet Brakes

These brakes were developed to meet the Association of Iron and Steel Engineers' d-c mill motor brake standard No. 11. D-c magnet brakes are used for heavy duty applications in mill drives, materials handling, marine service and on bridges.

A single adjustment at one end of the new brake is all that is needed to take care of lining wear, the manufacturer states. A self-centering ful-

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Get immediate delivery of samples; prompt action on volume orders for manufacture. Hundreds of different optical parts, production-run to the optical industry's highest precision standards.
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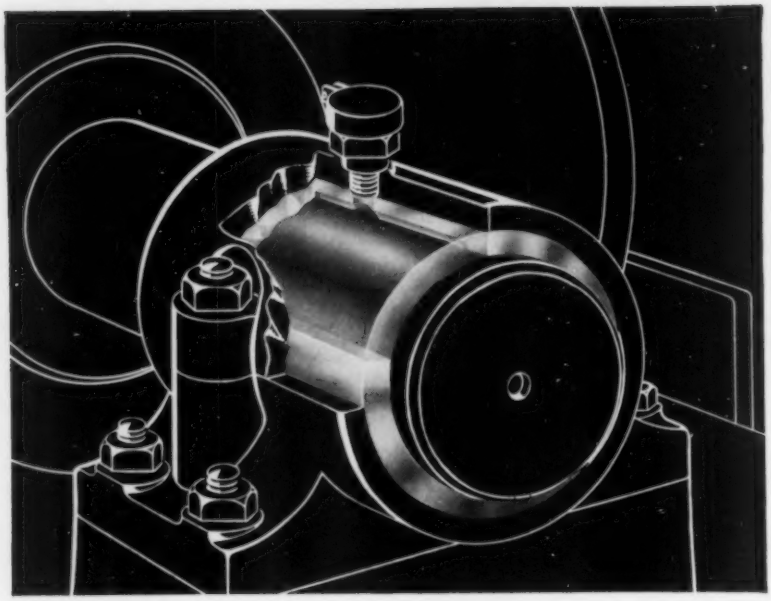
• Negative Meniscus Lenses
• Projection Condensers
• Achromatic Lenses
• Right Angle Prisms
• Crown Glass Wedge-Type Prisms
• First Surface Reflectors—Plane
• Second Surface Reflectors—Plane
• Parabolic Reflectors
• Cylindrical Strip Lenses
• Ground Glasses
• Heat Absorbing Glass
• Retardation Plates
WRITE for Catalog L-117, and for information on special orders. Bausch & Lomb Optical Co., 66834 St. Paul Street, Rochester 2, N. Y.
BAUSCH & LOMB
SINCE 1853



THE WAY TO CUT...

Cost of imitation

If you are using an expensive type of bearing because a competitor of yours uses it you are needlessly saddling expense onto your product if the job could be done as well or better with a less expensive type—as for example the cast bronze sleeve bearing.

Your customer buys your product because it does a job he needs done in the way he wants it done. Your company's name and reputation support your product, and the mere fact that you include unnecessarily expensive bearing types is not a factor in the sale. We suggest you examine your present designs to determine if there are not places where the sturdy, simple, cast bronze sleeve bearing can help you toward necessary cost reductions.

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Consult him. Or write our
Product Engineering Department in Toledo.

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crum automatically positions both shoes during adjustment, even if one lining has worn down more than the other. An easily visible gage, the armature gap indicator, shows the normal gap position and indicates when the brake should be adjusted. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 123, inside back cover

Measures Compressive Force Up To 10,000 lb

This instrument consists of a traction dynamometer mounted in a steel cage in such a manner that compressive loads applied are instantly indicated on its dial. The dimensions of the pressure cell are 9⅞ in. high x 9½ in. wide x 5 in. deep, with an approximate net weight of 42 lb. This instrument will handle an extremely wide range of testing applications, such as checking hydraulic and air presses, measuring journal bearing pressures, weighing heavy or bulky items. The new pressure cell is available in seven capacities, from 0-250 to 0-10,000 lb, and will withstand overloads up to 25 percent without injury to calibrations. W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

For more information—
Circle 124, inside back cover

Non-Inductive Resistors

Elimination of bobbins, lower cost, smaller size, much closer tolerance control and the successful combining of minimum inductance and capacitance effect are said to characterize these new resistors. Winding strains are eliminated. No artificial aging is required. The sealed-in ceramic tube completely seals out humidity, salt spray and also gives full protection against damage from soldering irons and other assembly tools. Each end seal is permanently bonded to the ceramic housings and lead wires, and protected from humidity by a tough waterproof coating. Windings are impregnated with silicones or other humidity-resisting materials as required for added protection.

For all high-value precision resis-

tors, special alloy wire with temperature coefficient of resistance of 0.002 percent per degree centigrade is used. For low value resistors, other alloy wires with comparable temperature coefficients of resistance are used. Terminals are 1½ in. lead wires of soft drawn No. 20 and No. 22 tinned copper wire. These wires are firmly soldered or welded to the resistance elements. A wide variety of sizes, shapes and resistances are available including hermetically sealed units. Monson Mfg. Corp., 6059 W. Belmont Ave., Chicago 34, Ill.

For more information—
Circle 125, inside back cover

Linear Displacement Transducer

This linear motion transducer produces an accurate linear relationship between a shaft linear displacement and an output voltage even with large displacements. It is designed in several sizes and packages for use in industrial automation as an electronic gage, monitor and control system sensor and for military applications such as accelerometer pickup and pressure transducer sensing element. Excitation voltage is 28 to 115 v, ac, and excitation frequencies, 60 to 600 cycles per sec. Output voltages are 3 v for a 28 v input, 30 v for a 115 v input. Temperature range is 65 to 165 F. General Cybernetics Associates, P. O. Box 987, Beverly Hills, Calif.

For more information—
Circle 126, inside back cover

Tungsten Carbide Hot-Pressed Parts

Smoother surfaces and closer tolerances are said to have been obtained in new line of hot-pressed tungsten carbide products. Typical examples of parts produced advantageously by this new method are drawing dies, bushings, mandrel tips and core rods for powder metallurgy. The finished parts are asserted to represent substantial savings compared to regular hot-pressed products because of the reductions in time, labor and grinding materials afforded, although the unit costs are slightly higher.

The new material is available in

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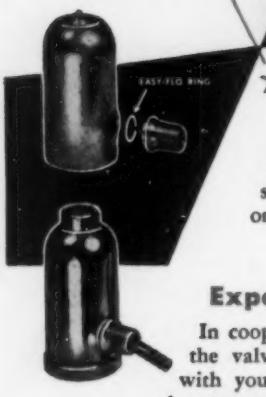
Amazingly simple EASY-FLO or SIL-FOS brazing pays big dividends



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Expert "Know-how" at your service

In cooperation with the manufacturer we worked out the valve brazing set-up – and we're ready to work with you. As originators of EASY-FLO and SIL-FOS low-temperature silver brazing alloys, we offer you the benefit of the maximum technical knowledge about the process and practical experience in its application available anywhere today. There's no obligation for this assistance. Just phone or write when you would like a field service engineer to call.

It's a safe bet you can get a better product at much lower cost on several of your metal parts by designing them for EASY-FLO or SIL-FOS silver brazed construction – supplemented by a simple production set-up that makes the brazing so easy – *anybody can do it!*

Here's an example – a radiator valve. It is made of a simple drawn body and a screw machine part, brazed with EASY-FLO. And the joining is done on a set-up that "automation-izes" the actual brazing. The net results – a smaller, trimmer valve – and a favorably low production cost.

FOR THE FACTS IN PRINT...

Write for Bulletin 20. It gives them all plus a lot of useful information about fast, low-cost production brazing.

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SEE the comprehensive exhibit of low-temperature silver brazing jobs from many industries. Our engineers with the know-how will be there ready and waiting to chat with you about your metal joining. BOOTH 342

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all grades of tungsten carbide that are conventionally used in hot-pressed products. This includes the range of cobalt contents from 6 to about 20 percent. The process is particularly applicable to the high cobalt (binder rich) compositions, where ordinary hot-pressed surfaces are roughened by "sweating out" of the binder. Sintercast Corp. of America, 134 Woodworth Ave., Yonkers 2, N. Y.

For more information—
Circle 127, inside back cover

Office-Size Whiteprinter

Over a thousand letter or legal-size copies of black line or colored line whiteprints can be produced an hour by this printer-developer. With either cut sheets or roll stock, maximum width that can be handled is 20 in.

The machine operates on 115 v, 60 cycle ac. Maximum speed is 30 fpm with manual operation and the drive is continuously and instantly variable. Peck & Harvey Mfg. Corp., Chicago, Ill.

For more information—
Circle 128, inside back cover

Variable Pitch Motor Pulley

Standard "A" section belts are used and the maximum rating of this pulley is ¼ hp at 1750 rpm. The new pulley is machined of cast iron and bearings are oil impregnated. Gerbing Mfg. Corp., Northbrook, Ill.

For more information—
Circle 129, inside back cover

Cathode-Ray Oscillograph

A new cathode-ray oscillograph capable of precise measurements of time and amplitude within the frequency range of dc to 5 mc is said to make available to medium frequency investigations the convenience and precision of a laboratory quality instrument, without the cost penalties of unneeded band width.

The linear vertical amplifier which can be precisely calibrated for full-scale deflection makes the Type 327 an accurate cathode-ray voltmeter. The fifty-nine precisely calibrated

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Users say, "Nothing like this ever before." Smooth, quiet operation with uniform response. New adjustable overload protection lets motors work harder with fewer nuisance interruptions.

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TEST IT!
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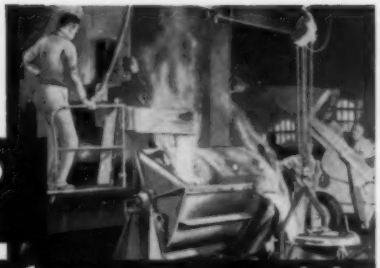

from raw material
to finished product

Viking's manufacturing plant plus both ferrous and non-ferrous foundries, featuring Sorbe-Mat castings, are all owned and operated as an integrated unit. This means rotary pumps that will operate better and longer for you.

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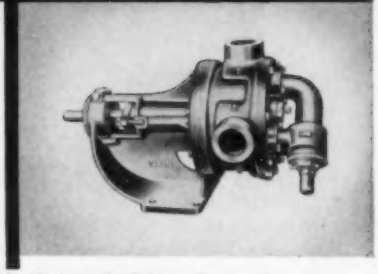

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BULLETIN 161

2 BULLETINS on SHORT RUN STAMPINGS

BULLETIN 101

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SERVICES BULLETIN NO. 161 describes the facilities that make Federal a *one-stop* stamping service. Specifications cover special die stamped wrenches, nameplates, and quality short run stampings from any stampable material.

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MINNEAPOLIS, MINNESOTA
"QUALITY STAMPINGS IN SMALL QUANTITIES"

steps of the sweep generator cover the range of 1 sec to 1 usec duration on a 1 in. scale. The instrument measures 15½x12½x22 in. and weighs 65 lb. Allen B. Du Mont Laboratories, Inc., Clifton, New Jersey.

For more information—
Circle 130, inside back cover

D-c Indicating Amplifier

This instrument amplifies and measures signals as small as 2x10-15 w. It uses a magnetic converter as the input stage. The limitations of the usual vibrator-type converters are avoided, and a higher degree of stability and reliability is achieved.

As an amplifier, the 2HLA-3 has a flat frequency response to greater than 20 cycles per sec on all five ranges and supplies sufficient power output to drive pen motor or galvanometer recorders. Its reported high gain, excellent linearity, and negligible drift are unaffected by variations in line voltage or tube characteristics.

As an indicator, accurate direct readings of the magnitude and polarity of the input d-c signals are given on a mirror-scale, zero-center meter. Doelcam Corp., 1400 Soldiers Field Road. Boston 35, Mass.

For more information—
Circle 131, inside back cover

Gear Tooth Lamination Reduces Backlash

A gear has been developed that is reported to be minimizing backlash in gear trains used in precision controls. These gears have a central lamination or wafer of nylon flanked on either side by steel. The blanks are cut and shaved by conventional methods.

After cutting, the nylon portion of the gear "grows" slightly to increase tooth thickness enough to reduce backlash to a negligible amount—but without increasing torque. The inner nylon portion is not relied on to assume any of the gear load. Load is taken entirely by the outside steel portions.

A typical example of the application of this new gear design is the gear box illustrated, which has a

90:1 ratio and an output torque rating of 30 in.-oz. Although 1.0 in.-oz friction torque was permitted, it is held to only 0.375 in.-oz. Backlash of the complete train measures only 0.02 deg. Dexter Machine Products Co., Chelsea, Mich.

For more information—
Circle 132, inside back cover

Potentiometer for Miniaturized Assemblies

Resistance of 20,000 to 1 megohm and infinite resolution are provided in this potentiometer, used for trimming or balancing circuits in electronic devices. Electrical adjustments of infinite accuracy are easily made by turning the slotted shaft with a screwdriver. The self-locking feature of the shaft eliminates lock-nuts. Electrical settings are said to be maintained during extreme conditions of vibration, acceleration and shock. These potentiometers may be mounted individually or in stacked assemblies. Dimensions are ¼ x ⅜ x 1¼ in. Power rating is 0.2 w. Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.

For more information—
Circle 133, inside back cover.

Six-Gun, 7-in. Cathode Ray Tube

This cathode ray tube displays up to six independent or related phenomena simultaneously on its 7-in. dia face. It is designed for multichannel oscilloscopes which must accurately display or record a number of transient, random or high frequency signals.

Electro-static focus and deflection, with adequate shielding against crosstalk, are used for all six electron guns. Each of the guns can be controlled independently, and scans all of the useful screen area. When the tube is operated at accelerating voltages of 2 and 4 kv, sensitivity of both the horizontal and vertical deflection plates is almost equal in each direction.

Leads for the deflection plates and pre-acceleration intensifying electrodes are brought out through the bulb wall

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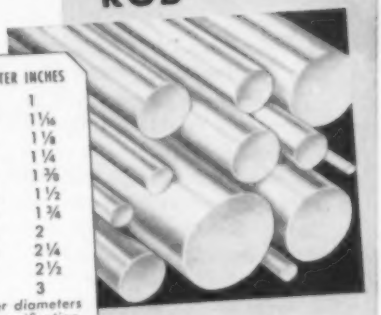
Thickness Inches	Nominal Size
1/16	12 x 12
3/32	18 x 18
1/8	24 x 24
3/16	36 x 36*
1/4	48 x 48*
3/8	
½ & Up	

* Can be furnished in ½ sheets

ROD



DIAMETER INCHES	
¼	1
5/16	1 1/16
⅜	1 ⅛
7/16	1 ¼
½	1 3/8
9/16	1 ½
⅝	1 ¾
¾	2
⅞	2 ¼
	2½
	3

Other diameters on specification

TUBING

TYPICAL SIZES INCHES	
O. D.	I. D.
⅜	¼
½	⅜
¾	½
1	¾
1 ½	1
2½	1½
3	1¾

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−300° to +500° F.

MECHANICAL
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Absolutely non-stick.

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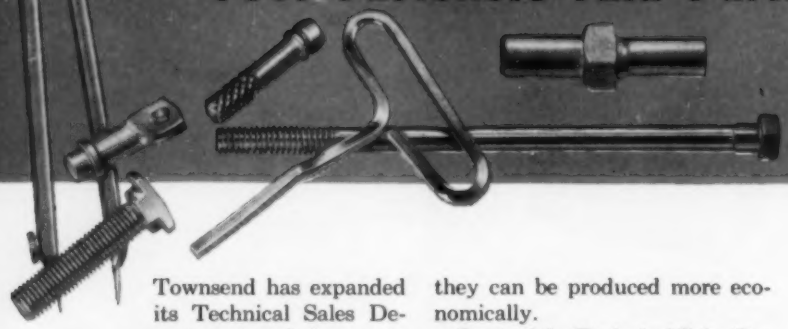

Townsend has expanded its Technical Sales Department to help you in your constant effort to improve your product, reduce unit costs and speed assembly. Here, a group of specialists works as a unit to devise the most economical and efficient methods of product assembly for all industry.

These men can serve you in several ways. They will visit your plant as fastening consultants to your design engineers and operating men. They will analyze a particular product and design special parts for it or suggest use of standard products in the assembly.

You may want them to study your entire production line for improved assembly techniques—they will even design a single part to solve a specific problem.

Another way to obtain the services of this department is to send drawings and samples of specific items for suggestions as to how they can be produced more economically.

Back of the Technical Sales Department is a company with nearly a century and a half of wire drawing and cold-forming experience. More than 10,000 standard and special parts and fasteners are produced regularly by Townsend.

In addition to the wide range of products and design experience at your command, Townsend has the tremendous capacity to produce 60-million pieces a day. This means you can depend upon Townsend to keep pace with your production lines since, in its several plants, there are enough machines of any type to handle a variety of long production runs simultaneously.

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Sales Department
New Brighton, Pa.

Please send Technical Sales Department Bulletin TL-98.

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Company _____

Street _____

City _____ Zone ____ State ____

to minimize lead inductance and capacitance and to improve insulation. Connections are easily made to the basing ring provided for the purpose. Overall size of the tube is 19 by 7 in. Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.

For more information—
Circle 134, inside back cover.

D-c Tachometer Generator

A line of d-c tachometer generators incorporating a permanent-magnet field assembly have an overall body length of less than 1½ in. and a weight of less than 3 oz. Although used principally as a rate generator in servo systems, these units can be used as speed indicators or as speed synchronizing controls.

The new line has a housing fully machined from solid aluminum to precision tolerances, low-torque ball bearings. The output voltage is controlled to within 1 percent of the same value for either direction of rotation. Models are available with an output of 2.5 v as well as with 7 v per 1000 rpm. A flange mounting arrangement is usually used, although a synchro type mount is available without additional charge. Servo-Tek Products Co., Inc., 1086 Goffle Road, Hawthorne, N. J.

For more information—
Circle 135, inside back cover.

Vibration Fatigue Test Machines

Both models of a new type of automatic frequency control change acceleration rate automatically. Starting with a frequency of 10 cycles per sec, acceleration may be increased uniformly to 60 cycles per sec, or held at any range between 10 to 60 cycles, such as 16 to 31 cycles. After finding the critical range, components undregoing test may be held at that range to determine final breakdown point. Selector may be shut off and cycling operated manually.

Tables of both models are 18x21 in. and they have 32 tapped holes, jig drilled in a symmetrical pattern. Fixtures or the test part itself can readily be turned 90 deg. This pattern

also permits interchangeability of fixtures between the two models, which are of 100 and 150 lb capacity. All American Tool and Manufacturing Company, 8027 Lawndale Avenue, Skokie, Illinois.

For more information—
Circle 136, inside back cover.

Porous Carbon Is 75 Percent Air

Highly porous yet extremely fine-grain carbon that is said to be 75 percent air retains the usual, desirable carbon characteristics such as high electrical conductivity, resistance to chemical attack and stability under high temperatures. The new carbon offers possibilities for impregnation or for use as filter plates. Its extremely fine grain results in a large carbon surface area despite the high porosity of the material. The new material is available either in blocks or in sheets up to approximately 10x10 in. and of practically any desired thickness up to 1½ in. Stackpole Carbon Co., St. Marys, Pa.

For more information—
Circle 137, inside back cover.

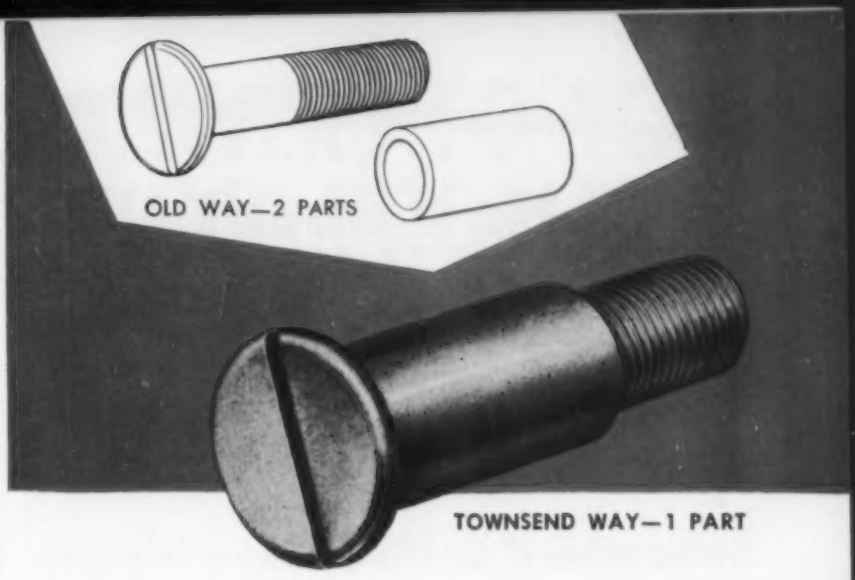
Ten-Turn Potentiometer Of 1-in. Dia

This unit has 26½ in. of coil length, said to make it possible to guarantee accuracies of ±0.25 percent standard in a resistance range of 4,000 to 200,000 ohms. Mechanical and electrical rotation of this new ten-turn potentiometer are 3600 deg, + 5 deg, −0 deg.

The Type 920 is available with three mountings, standard three-hole mounting, servo mounting and threaded bushing mounting. The unit can be ganged; single-wire, all-welded taps can be provided and it has a ¼-in. dia shaft. Body and supporting of metal construction.

Starting torque of 1 in.-oz and running torque of ½ in.-oz. makes it possible to utilize small servo-motors with low power. Fairchild Camera & Instrument Corp., 225 Park Ave., Hicksville, N. Y.

For more information—
Circle 138, inside back cover.



How One Townsend Part Does The Work Of Two

Combining the functions of two parts or more into a single cold-headed piece is a routine operation at Townsend. It's an operation that will help you simplify design, speed assembly and reduce inventory problems. This results in improved products and lower unit costs.

The bolt and sleeve above were assembled by hand and used to fasten a pulley in a household automatic clothes dryer. It was difficult to obtain a tight connection with the two pieces, which often resulted in excess vibration. Complaints and maintenance calls were numerous. The parts came from two suppliers which doubled the detail of purchasing and inventory control.

All of these problems were quickly solved by Townsend. The Technical Sales Department designed the single cold-headed part shown above which does the work of the two pieces. Assembly is speeded, purchasing and inventory control simplified. The biggest advantage, of course, is the tight, permanent connection achieved with the Townsend part, which eliminates a headache for manufacturer and dealer alike.

This is just one typical example of how the Townsend method of producing cold-formed parts and fasteners improves products and reduces unit costs for manufacturers in the appliance industry and other industries as well.

To learn quickly how Townsend, as "The Fastening Authority," will work with you to reduce assembly costs, ask to have an engineer call. For additional information, use the coupon below or write for illustrated bulletin.

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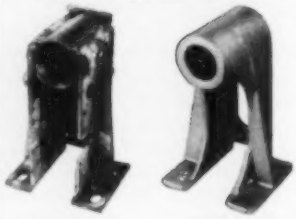
Malleable Casting Reduces Weight of Roller Guide 26%



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CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

Investment Castings–Booklet, 12 pp, discusses in detail basic design principles as they apply to investment casting processes. A materials chart listing physical properties and use of some of the more popular metals is also included. Case histories are also provided. Midwest Precision Castings Co., 2790 Grand Ave., Cleveland 4, Ohio.

Circle 139, inside back cover.

Tracer Control System–Bulletin GEA-6122, 6 pp. Automatic control of one or more machine motions is described and through the use of diagrams, the operation and components of the basic tracer system and its variations is illustrated. Designed for production use on milling machines, vertical boring mills and lathes, the tracer control automatically follows templates. General Electric Co., Schenectady 5, N. Y.

Circle 140, inside back cover.

Quartz Crystals–Brochure, 6 pp. explains a new approach to the method of specifying the custom made crystals produced by this company. All the pertinent information needed for ordering quartz crystals is included. For convenience, such variables as crystal holder type, temperature range, frequency tolerance over temperature range and calibration are reduced, via tables, to code form. General Electric Co., Syracuse, N. Y.

Circle 141, inside back cover.

Fluorothene Resins–Booklet, 16 pp. A digest of the latest information about these resins in graphs, tables and text. Recommendations on extrusion, injection and compression molding of

fluorothene resins are included in a section on fabrication. Bakelite Co., 260 Madison Ave., New York 16, N. Y.

Circle 142, inside back cover.

Patterns for Castings—Buyers guide has slide chart on cover which shows pattern recommendations according to casting quantity requirements. Contains a complete glossary of terms and is illustrated. A brief description is given of the features found in the following equipment: cast iron patterns, brass patterns, permanent molds, aluminum patterns and match plates, hardwood equipment, pine patterns of various grades and green-sand core molds. Master Pattern and Mold Co., Cleveland 13, Ohio.

Circle 143, inside back cover.

Bearing Bronze—Bulletin, 6 pp, gives available length, sizes, machine time, metallurgical characteristics and physical properties of continuous cast (SAE660) bearing bronze. American Smelting & Refining Co., Barber Station, Perth Amboy, N. J.

Circle 144, inside back cover.

Variable Speed Motor Controls—Brochure, 8 pp. Tells how grid-controlled, full or half-wave rectifiers are used to operate and control d-c motors from an a-c power source. Electro Devices, Inc., 4-6 Godwin Ave., Paterson 1, N. J.

Circle 145, inside back cover.

Solenoids and Relays—Catalog, 6 pp. Rotary solenoids and relays made of these solenoids combined with rotary switches are described and illustrated. Charts and drawings give dimensions, typical torques. G. H. Leland, Inc., Dayton 2, Ohio.

Circle 146, inside back cover.

Air Control Equipment—Bulletin 75, 12 pp. describes a new line of control devices, consisting of air regulators, filters, lubricators, automatic drain traps, quick-coupling connectors, and rotary air seals. New principles of operation are explained and illustrated. Perfecting Service Co., 332 Atando Ave., Charlotte 6, N. C.

Circle 147, inside back cover.

Thermocouple Elements—Booklet, 6 pp. Discusses elements made of noble and base metals for high-temperature

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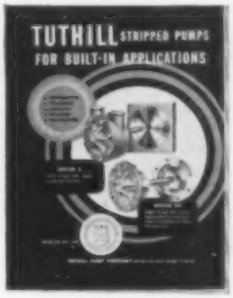

CATALOG 106—(Types S and SA) Stripped pumps for built-in applications. Capacities from ½ to 200 g.p.m. and pressures to 100 p.s.i.

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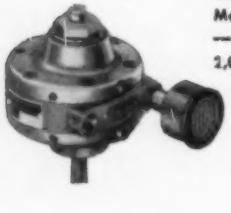

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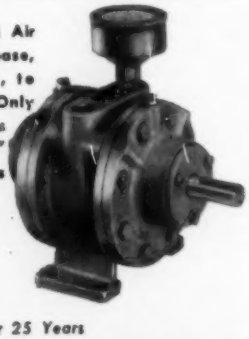

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Catalogs and Bulletins.....continued

instrumentation and control. Various types of insulators, protection tubes and lead wires are also described. Charles Englehard, Inc., 850 Passaic Ave., E. Newark, N. J.

Circle 148, inside back cover.

Motors and Collector Rings—Booklet, 8 pp, describes torque and special motors and also contains engineering drawings and tabular data on collector rings. B. A. Wesche Electric Co., 1623 Vine St., Cincinnati 10, Ohio.

Circle 149, inside back cover.

Ball Screws—Folder, 4 pp, provides tables and curves describing properties and characteristics of these devices, used to convert rotary motion to linear or force input to torque output. Beaver Precision Products, Inc., 651 N. Rochester Road, Clawson, Mich.

Circle 150, inside back cover.

Steel Safety Plate—Booklet, 16 pp, describes slip-resistant steel plate, providing detail drawings of applications and a table of safe loads. Inland Steel Co., 38 S. Dearborn St., Chicago 3, Ill.

Circle 151, inside back cover.

Rectangular Miniature Connector—Bulletin, 2 pp, includes schematic drawings, electrical and mechanical specifications, available contacts. De-Jur-Amsco Corp., 45-01 Northern Boulevard, Long Island City 1, N. Y.

Circle 152, inside back cover.

Miniature Time Delay Relays—Bulletin describes miniature, hermetically-sealed relays for either a-c or d-c units, giving characteristics and factors which might determine type of timer to be used. A. W. Hayden Co., 230 N. Elm St., Waterbury, Conn.

Circle 153, inside back cover.

Fph Adjustable Speed Drives—Bulletin FA52, 8 pp, contains photographs, charts, graphs and line drawings, detailing fundamentals of operation, capacity of units available, mechanical construction features, control. Eaton Mfg. Co., Kenosha, Wis.

Circle 154, inside back cover.

Packings—Six 4-pp technical bulletins. Each contains factual information on, and standard sizes of, a specific style of packing. Included are: rubber "O"-ring packings and both rubber

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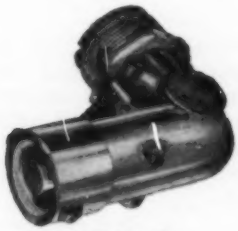

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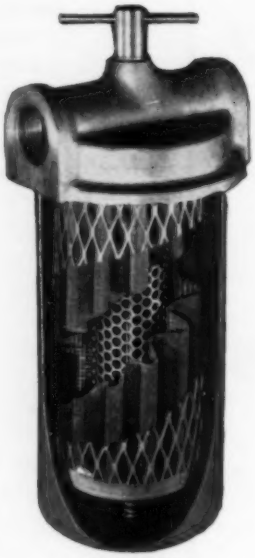

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PE-10

and leather gaskets, back-up washers, "V"-cups, "U"-cups. Data on this company's rubber-impregnated leather is also provided. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

Circle 155, inside back cover.

Metal Rupture Discs—Catalog sheets describe uses for frangible discs in the protection of pressure systems wherever over-pressure is a problem. Diagrams and tabular material provide design recommendations. Frangible Discs, Inc., 57 Railroad Ave., Penns Grove, N. J.

Circle 156, inside back cover.

Aluminum Designation System—Wall chart shows the new four-digit system, developed by the Aluminum Association, which became effective October 1, 1954. This conversion guide indicates old and new designations in bold type and has been designed as a permanent reference. It may be used either as a wall chart or punched and inserted in a three-ring binder. Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, Calif.

Circle 157, inside back cover.

Temperature Regulators—Bulletin S-6, 12 pp, explains where and when to use direct-acting, reverse-acting and three-way type thermostatic temperature regulators and lists typical engineering specifications. Also explains where and how to use single and double-seated valves. Illustrated with cutaway photos and diagrams, installation diagrams and engineering tables. Lawler Automatic Controls, Inc., 453 N. MacQueston Pkwy, Mt. Vernon, N. Y.

Circle 158, inside back cover.

Solders—Booklet, 8 pp, gives sizes, compositions, melting points and other information on cored solder wire, preforms, solid solder, fluxes. Enthoven Solders, Ltd., 89 Upper Thames St., London E. C. 4, England.

Circle 159, inside back cover.

Industrial Glass Products—Catalog 53A, 16 pp, includes application data tables which cover dimensions, weights, wall thicknesses and prices of glass tubing and rod, capillary tubes, low pressure gage glass tubes,

oil cup glass cylinders and glass wool fiber used in filtration processes. Friedrich and Dimmock, Inc., Millville, N. J.

Circle 160, inside back cover.

Worm Gear Speed Reducers–Bulletin HW-654, 8 pp. Tables and engineering drawings provide dimensions, shaft arrangements, ratings, overhung loads, torques of Series C reducers. Winsmith, Inc., Springville, N. Y.

Circle 161, inside back cover.

Metal Tubes and Tubular Assemblies–Folder, 4 pp, describes typical tubular products and assemblies. Elano Corp., Xenia, Ohio.

Circle 162, inside back cover.

Mechanical Power Transmission–Catalog B20-53, 8 pp, describes and illustrates silent chain and roller chain drives; sprockets, cable chains, drive shafts, couplings and clutches. Specifications, stock sizes, applications are included. Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

Circle 163, inside back cover.

Industrial Rubber Products–Catalog 35C, 20 pp, covers "V"-belts, transmission belts, conveyor belts, all types of hose, molded products. Raybestos-Manhattan, Inc., Passaic, N. J.

Circle 164, inside back cover.

Shock, Vibration and Noise Isolation–House organ, 4 pp. First issue contains a report on shock mounts as a means of increasing validity of shock tests. Descriptions of available literature and some installations also included. Barry Corp., 700 Pleasant St., Watertown, Mass.

Circle 165, inside back cover.

Air and Hydraulic Cylinders–Catalog 750, 12 pp. Design elements, capacities, working pressures, dimensions, accessory parts and compenents are described and illustrated. Hanna Engineering Works, 1765 Elston Ave., Chicago 22, Ill.

Circle 166, inside back cover.

Multiple Stage Flowmeters–Bulletin 1053, 2 pp, includes designs and construction features, maximum flow ranges, and various combinations of metering tubes and bypass valves

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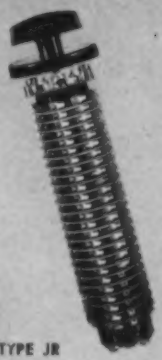
For every control, tap, and transfer application.



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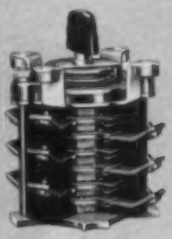

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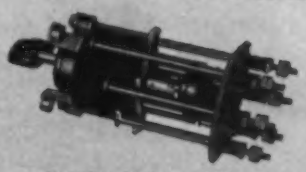

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Catalogs and Bulletins.....continued

which can be used in series. Commercial Research Laboratories, Inc., 20 Bartlett Ave., Detroit 3, Mich.

Circle 167, inside back cover.

Ball-Bearing Swivel Joints—Catalog, 32 pp, describes swivel joints, loading racks, manifolding lines, all-metal marine and barge hose and flexible aircraft assemblies. Chiksan Co., Brea, Calif.

Circle 168, inside back cover.

Ball-Bearing Swivel Fittings—Bulletin FS-107, 4 pp. Small size high-pressure and high-temperature ball-bearing swivel fittings ranging in size from $\frac{3}{8}$ to 1 in. and for working pressures of 6,000 psi at 225 F to 1,250 psi at 750 F are described. Construction and application, dimensions, specifications, weights, sectional drawings and various types of packing for steam, hot water, oil, liquefied petroleum gases and chemicals are included. Emsco Mfg. Co., P.O. Box 2098, Terminal Annex, Los Angeles 54, Calif.

Circle 169, inside back cover.

Gears and Reducers—Bulletin 789-54, 4 pp. Condensed chart gives typical horsepower ratings at pinion speeds of 100 and 1750 rpm and weights of units from 2 to 18 in. center distance. Michigan Tool Co., 7171 E. McNichols Road, Detroit 12, Mich.

Circle 170, inside back cover.

Shell Molding—Booklet, 36 pp, is a basic guide to shell molding as a production process, but chapters on patent status, merits of technique, pattern requirements and required equipment are of interest to design engineers. Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y.

Circle 171, inside back cover.

Molded Silicone Rubber Parts—Booklet, 8 pp, contains information on properties, design specifications and some typical applications of silicone rubber parts such as O-rings, gaskets, bellows, insulators. Acushnet Process Co., New Bedford, Mass.

Circle 172, inside back cover.

Industrial Pumps—Catalog I-54, 108 pp, describes almost every pump now made by this manufacturer. Information on construction features, per-

OILGEAR DRIVES ON GLAMORGAN CENTRIFUGAL PIPE CASTING MACHINE

Something more than 5 years ago, the Glamorgan Pipe & Foundry Company, of Lynchburg, Va., a leading manufacturer of cast iron pipe, designed its own centrifugal pipe casting machine, using Oilgear Fluid Power equipment to tilt the ladle and move the casting carriage.

The degree of control over pouring rate and carriage travel afforded by Oilgear has had almost unbelievable results. Scrap caused by irregularities in moving parts has become negligible. Weight controls are well within the close limits set by Industry specifications. Only 3 men are needed to operate the equipment. Despite the fact the machine has averaged 500 operations per day since 1948, maintenance on Oilgear equipment has totaled less than $200.00. The fumes and dirt necessarily present in foundry operations have had no effect on Oilgear fluid power equipment.

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Sure it takes power to tilt a ladle and move a pipe casting machine carriage. But above all, it takes absolute and precise control of the speed of pouring and the speed of carriage travel if the product is to be perfect and uniform.

It not only takes power but power under control to print in register on flimsy cellophane at high speed, to set up paper piles for repetitive serial cuts to hairline register automatically, to cut fish on a continuous conveyor to accurate weight for canning, to vary the speed of a large beater automatically to conform sensitively to the changing viscosity of the mass.

These are all triumphs of Oilgear Fluid Power—where this flexible, controllable, versatile power leads the way to better machine design or to the solution of hitherto unsolved problems.

Think of Oilgear Fluid Power as identical with electrical power . . . generated by a pump . . . applied over conductors through a motor or motor element. But Oilgear Fluid Power can be converted into linear movement as well as rotary; can be exerted statically, without motion; can be varied infinitely, steplessly without additional equipment.

And the unique Oilgear design is oil hydraulic design at its simplest and best. It is generally accepted as the leader in its field. It will cost you nothing to see what Oilgear can do to improve the salability of your equipment . . . may profit you and your users in an amazing degree. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wisconsin.

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WELDED DESIGN REDUCES VIBRATION CUTS COSTS

CONTRARY to traditional belief, high-speed machinery like printing presses can be made from welded steel to run faster, smoother with minimum adjustment for register. Savings in cost are up to 50% compared to former cast designs.

This 75-foot welded steel press built by Goss Printing Press Company for a popular magazine publisher runs at 11,500 impressions per hour compared to 4,000 by the press it replaced. Yet, vibration is less, make-ready is faster, fewer adjustments are needed.

The housing for the folder frame on this Goss Printing Press (Figure 1) previously weighed 405 pounds . . . cost $683.00. The welded steel frame weighs only 300 pounds, costs only $123.00 *. . . an 84% reduction in cost.*

The folder bed plate (Figure 2) was a 4,113-pound casting and cost $1,725.00 to cast and machine. The welded bed plate now used weighs 3,000 pounds and costs only $248.00.

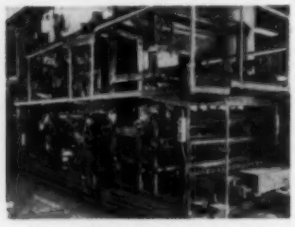

Fig. 1. Saves $560.00 per frame *by converting to welded steel design. Weight is cut from 405 to 300 pounds per frame.*

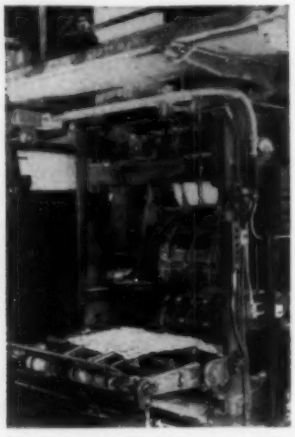

Fig. 2. Saves 1,113 pounds *cost down 86% on press folder bed plate.*

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Machine design sheets showing how to simplify design, save metal and cut costs are available to product engineers and designers by writing on your letterhead.

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formance and selection tables for centrifugal, sump, vertical, submersible, oscillating, rotary and other types is given and several pages of information relating to liquid materials handling problems are included. Deming Co., Salem, Ohio.

Circle 173, inside back cover.

Torque Converter Coolers–Catalog 1054, 8 pp, contains descriptions, photographs, drawings of cooling units for both starting and mobile equipment. Young Radiator Co., Racine, Wis.

Circle 174, inside back cover.

Domestic Water Systems Control–Bulletin GEA-6119 6 pp, illustrates the design features and application of pressure switches, submersible pump control panels and internally and externally mounted sump-pump switches. Diagrams and photographs show installation and operation details. General Electric Co., Schenectady 5, N. Y.

Circle 175, inside back cover.

Hose and Hose Assemblies–Catalog, 16 pp, describes aircraft hose and assemblies for fuel, oil and hydraulic systems. Size, operating data and construction features are included. Resistoflex Corp., Belleville, N. J.

Circle 176, inside back cover.

Insulation Resistance Tester–Bulletin 21-20, 23 pp, gives ratings, voltage characteristic curves, specifications of both hand-cranked and motor-driven, rectifier-operated test equipment. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.

Circle 177, inside back cover.

Grommets–Brochure, 16 pp, lists materials and types of grommets available in 34 basic sizes, each size available with $\frac{1}{16}$, $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ in. groove widths and the 34 sizes in the web type with $\frac{1}{16}$ in. groove width. Goshen Rubber Co., Inc., Goshen, Ind.

Circle 178, inside back cover.

Transformers–Catalog CT-554, 32 pp, contains descriptions of over 500 stock transformers for military, new equipment, general replacement and power and control circuit applications. A simplified classification system makes it easy to locate any particular unit and the dimensions of all cased units are shown diagrammatically. Chicago Standard Transformer Corp., 3501 Addison St., Chicago 18, Ill.

Circle 179, inside back cover.

Cantilever Shaft Couplings–Bulletin 28, 4 pp, illustrates and describes couplings rated from $\frac{3}{4}$ to 1500 hp. Included is a list of available sizes with dimensions, weights and safety factors for use with various types of equipment. Brown Engineering Co., 23 N. 3 St., Reading, Pa.

Circle 180, inside back cover.

A-c Rate Generator–Bulletin, 4 pp, illustrates and describes a line of rate generators with high functional voltage output. Information on construction, applications, design features, characteristics and specifications are provided. Also included is a section on rate generator–servo motor packages, which combine, in single-shaft units, rate generators and high-precision servo motors. Ford Instrument Co., 31-10 Thomson Ave., Long Island City 1, N. Y.

Circle 181, inside back cover.

Bearing Alloys–Catalog, 20 pp. A group of light-weight, high-strength copper-zinc alloys are described and metallurgical data given. A comprehensive chart provides nominal chemical compositions, mechanical and physical properties. Typical applications also included. Mueler Brass Co., Port Huron, Mich.

Circle 182, inside back cover.

Lubricating Greases–Folder, 4 pp, lists and describes both graphited and non-graphited lubricants and gives consistencies and recommended service details. Gredag, Inc., Niagara Falls, N. Y.

Circle 183, inside back cover.

Flat Ground Tool Steels and Drill Rods–Wall chart gives stock sizes of flat ground tool steels and drill rods. Uddeholm Co. of America, Inc., 155 E. 44 St., New York 17, N. Y.

Circle 184, inside back cover.

Power Transmission and Materials Handling–Catalog 950, 340 pp, describes chains and sprockets for conveying, elevating and power transmission, gear drives of various types,

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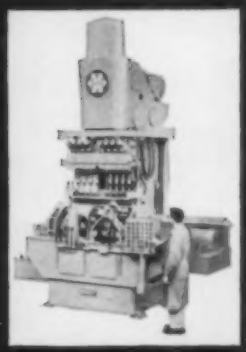
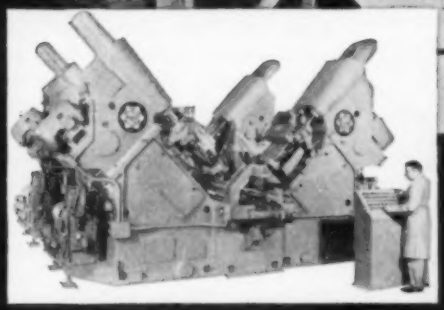
Production • Accuracy • Economy

V-8 Cylinder Blocks are MICROHONED Automatically on NEW Model 420 Hydrohoners ☆

Specifications of this model are included in our general catalog—obtainable at the offices listed below.





This multiple-spindle, heavy-duty model is designed to fit any type of production line. Examples of its adaptability: above, two four-spindle machines with tip-up fixtures; left, V-type; upper right, eight spindle vertical.

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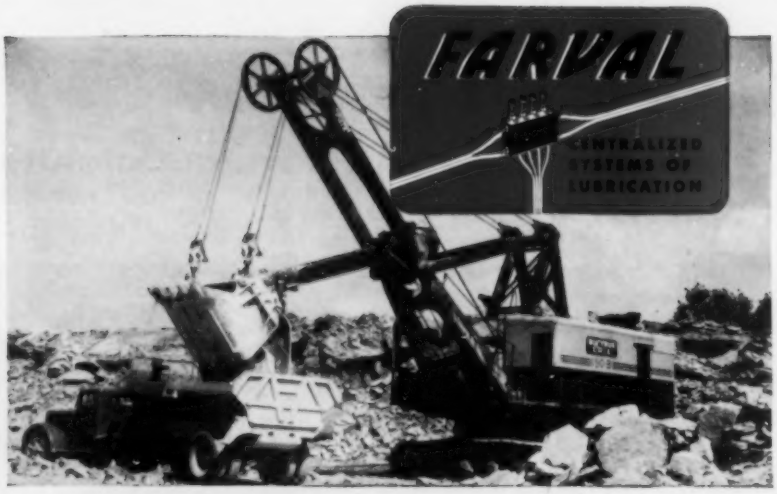

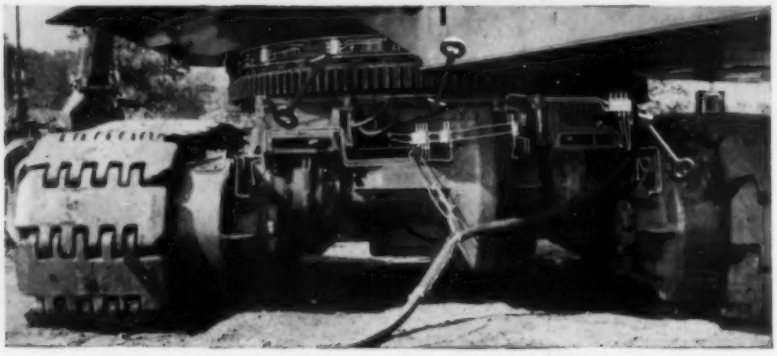

KEYS TO ADEQUATE LUBRICATION—Wherever you see the sign of Farval—the valve manifolds and dual lubricant lines—you know a machine will be properly lubricated. Pictured is the Farval-lubricated frame of a Bucyrus-Erie Model 150-B 6-cubic-yard power shovel.

Now—mine shovels work longer at less cost with Farval lubrication

SHOVEL bearings take terrific jolting in pit mining service. Unless they are properly lubricated at all times, you're in for shutdowns, lost time and repair bills. That's why it pays to install Farval Centralized Systems on quarry and mine shovels.

FARVAL is the foolproof Dualine system of centralized lubrication that delivers a measured amount of clean lubricant at regular intervals to every bearing. From a central station, lubricant is pumped under pressure to a measuring valve at each bearing, delivering the exact amount of lubricant required. Grit, abrasive sand or dust that may have penetrated bearings is forced out by lubricant pressure, and the lubricant forms a protective seal. Possible bearing failure due to hit-and-miss hand oiling is eliminated. Shovels work better and longer.

On this Bucyrus-Erie 150-B, for example, Farval takes only a minute or two to lubricate every bearing needing protection. Compare this to the time lost on a shovel that has to shut down for 15 to 20 minutes every time the operator needs to lubricate by hand! Another point—Farval saves up to 3 of every 4 pounds of lubricant used by other methods.

FREE LUBRICATION SURVEY

Let us send one of our lubrication engineers to inspect your heavy equipment. Without obligation, he will present a written analysis of what Farval can do for you. Write for Bulletin 26 for the complete Farval story.

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Farval is an affiliate of The Cleveland Worm & Gear Co., Represented in Canada by Peacock Brothers, Limited

ball and roller bearings and accessories, pulleys, clutches and couplings, screw, belt, and oscillating conveyors and bucket elevators. Stock products are readily identified, with listings of pre-selected assemblies and capacity charts and dimension tables. Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill.

Circle 185, inside back cover.

Silver-Zinc Batteries—Brochure, 6 pp, includes technical data charts and specifications. American Machine & Foundry Co., 261 Madison Ave., New York 16, N. Y.

Circle 186, inside back cover.

Fluxless Soldering—Booklet, 6 pp, describes new ultrasonic soldering process and equipment. Some technical data included. Aeroproducts, Inc., West Chester, Pa.

Circle 187, inside back cover.

Electronic Controls—Booklet F6437, 24 pp. Simplified diagrams and descriptions explain elements of electronic control, including the bridge circuit, sensing elements, type of control and control applications. In addition to proportioning temperature control this booklet goes into on-off temperature control, humidity control and outdoor reset hot water control. Barber-Colman Co., Rockford, Ill.

Circle 188, inside back cover.

Tank and Duct Lining—Bulletin, 4 pp, describes "Koraseal" sheet lining for racks, vats, stacks. List of materials and solutions and maximum temperatures at which they can be safely handled by this lining are included. Metaweld, Inc., Scotts & Abbottsford Ave., Philadelphia, Pa.

Circle 189, inside back cover.

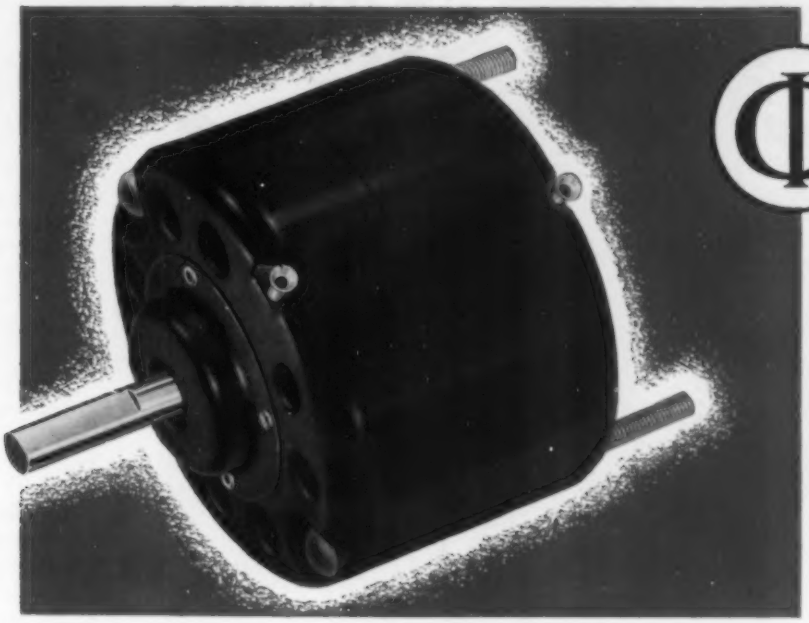
Vibration Meter—Bulletin CEC-1505C, 4 pp, provides sensitivity, range, frequency response and other engineering data on device for determining amplitude and velocity of almost any type of oscillatory motion. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle 190, inside back cover.

Miniature Wire and Cable—Catalog, 16 pp. Stranding, operating voltages,

Announcing NEW

Smooth Power MOTORS



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Newest addition to the famous "Smooth Power" line! – and built with all the quality and care you expect from G. I. motors. Features include: shaded 4-pole, 4-coil design ● self-aligning, self-lubricating bronze bearings ● dynamically balanced rotor ● moisture-proof, baked varnish-impregnated windings ● ample bearing oil reservoirs, located for easy lubrication. Designed for 115 volts, 60 cycle AC. Modifications in shaft length, diameter, etc., available in production quantities. Call, Write or Wire Today for Full Information.

MODEL	HP 1550 RPM	Running Torque In/Oz	Length	Diameter	Shaft Diameter	Mounting Stud Size	Weight Lbs.
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B-8-CW B-8-CCW	1/70	13.5	2-5/16	3-17/64	5/16	10-32	2.7
B-11-CW B-11-CCW	1/45	16.5	2-11/16	3-17/64	5/16	10-32	3.4
DATA BASED ON 115 VOLTS 60 CYCLE INPUT. CHARACTERISTICS CAN BE VARIED DEPENDING ON AIR FLOW OVER MOTOR.							

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dimensions, insulation details of wire and cable for service up to 250 C are given. Tensolite Insulated Wire Co., Inc., Tarrytown, N. Y.

Circle 191, inside back cover.

Tube Shields, Holders, Clips–Bulletins (3), 2 pp each, give dimensions and other data. Staver Co., Bay Shore, N. Y.

Circle 192, inside back cover.

Miniature Repeat Cycle Timers–Bulletin AWH-RC200, 2 pp, contains information on a line of miniature, hermetically-sealed repeat cycle timers. Describes cycling time, timing accuracy and determination of timing tolerances. A. W. Haydon Co., 230 N. Elm St., Waterbury, Conn.

Circle 193, inside back cover.

Centrifugally Cast Bar Stock–Bulletin 152, 4 pp, Tubular and solid types of cast bar stock are described and properties given. Shenango-Penn Mold Co., Dover, Ohio.

Circle 194, inside back cover.

Commutator Motors–Catalog EI-2A, 22 pp, covers over 250 models of commutator-type motors. Electrical characteristics, ratings and other details are given in tables, curves, photographs and engineering drawings. Electric Indicator Co., Springdale, Conn.

Circle 195, inside back cover.

D-c and A-c Generators–Catalog EI-1A, 24 pp, Electrical and physical specifications are listed along with performance curves and dimensional drawings for permanent-magnet and wound-field d-c, a-c and sine wave generator types. Details are included on tachometer generators. Electric Indicator Co., Inc., Springdale, Conn.

Circle 196, inside back cover.

Electric Motor Controls–Catalog, 140 pp, contains engineering and design data, including wiring diagrams. Magnetic starters and contactors, combination starters, control panels, drum controllers, master, foot and pressure switches are described. Furnas Electric Co., 1050 McKee St., Batavia, Ill.

Circle 197, inside back cover.

Powdered Metal Parts–Booklet, 14 pp, describes typical parts that have been made of powdered metal, to-

gether with costs. Composition and properties of available alloys, machinability, suggested tolerances and other design factors are discussed. Yale and Towne Mfg. Co., 9335 Belmont Ave., Franklin Park, Ill.

Circle 198, inside back cover.

Hydraulic and Pneumatic Controls–Catalog 4G, 33 pp. Manual, solenoid and solenoid, pilot-operated valves and pressure switches are described and flow-patterns, capacities and ratings, port sizes, weights, current requirements, operating ranges are given. Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 199, inside back cover.

Diesel Engines–Bulletin 194A, 11 pp, design, ratings, various arrangements of engines and accessories, typical installations of four-cycle, one-, two- and three-cylinder engines for continuous or standby service. Nordberg Mfg. Co., Milwaukee, Wis.

Circle 200, inside back cover.

Plastic Electrical and Electronic Parts–Folder, 4 pp, illustrated with terminals, connector parts and other plastic components. Whitso, Inc., 9330 Byron St., Schiller Park, Ill.

Circle 201, inside back cover.

Iron Castings–Glossary of terms, 36 pp, explains over 150 technical terms as used by suppliers and users of ferrous and non-ferrous castings. International Nickel, New York 5, N. Y.

Circle 202, inside back cover.

D-c Indicating Amplifier–Bulletin 1-A, 2 pp. Engineering data and performance curves are presented along with typical applications and a discussion of the principle of operation. Doelcam Corp., 1400 Soldiers Field Road, Boston, Mass.

Circle 203, inside back cover

Centrifugal Pumps–Bulletin 110, 12 pp, has specifications of all models, performance data, dimensional drawings, instructions on stuffing boxes and mounting diagrams. Eastern Industries, Inc., 100 Skiff St., Hamden 14, Conn.

Circle 204, inside back cover.

Live-Pilot Bearing Bushings–Catalog, 8 pp, has application photographs,

AUTOMATION at work ...supported by ACME Weldments

18,240 operations – 80 automobile transmission cases every hour! That adds up to quite a day's work, but it's no problem for this transfer machine built by the Baush Machine Tool Company of Springfield, Massachusetts. Unusual sectional design permits rapid retooling, keeps work handling to a minimum, and speeds production in many of America's largest automotive plants.

To provide the *strength* and *rigidity* required by this complex, automatic machine, Baush engineers specified all-welded steel bases fabricated by *Acme Welding*. Beside being stronger these Acme weldments are lighter and make possible the incorporation of many exclusive design features. Perhaps these advantages of Acme weldments are important to your product . . . whatever your requirements, why not call on Acme *today*.

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GOING FAR BEYOND the limitations of stepping switches that operate in only one direction, STERLING'S new Type SS Stepping Switch operates in *both* directions!

This *bi-directional* stepping switch, having *two* driving magnets, is normally equipped with a 4-level, 12-position bank and wipers. The wiper shaft is rotated—either clockwise or counterclockwise, in 10° increments—by an intermittent ratchet-and-pawl action, depending on which of the electro-magnets is energized. Interrupter contacts act as an interlock to protect against partial steps and to permit self-stepping. Limit switches stop rotation at the end of the bank travel. Coils are available for DC currents up to 120 volts.

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For further details, write STERLING ENGINEERING COMPANY, INC., 54 Mill Street, Laconia, N. H. (Subsidiary of American Machine & Foundry Company).

Another AMF Product

Sterling RELAYS

engineering data and information on uses and performance of live-pilot bearing bushings. Donley Products, Inc., 11106 Avon Ave., Cleveland 5, Ohio.

Circle 205, inside back cover.

Investment Casting—Catalog 120, 8 pp, has design information, data on recommended tolerances and listings of alloys regularly cast. Casting Engineers, Inc., 2323 N. Bosworth Ave., Chicago 14, Ill.

Circle 206, inside back cover.

Electric Motors—Brochure 400, 4 pp, is based on tests conducted in accordance with AIEE standards and were witnessed by an independent authority. Information is presented in tabular form for engineering performance and in color charts as to what the results prove in relation to use. General Dynamics Corp., Bayonne, N. J.

Circle 207, inside back cover.

Boro-Carbon Resistors—Bulletin L-33, 2 pp. Detailed specifications and performance data obtained after extensive testing is provided. Shallcross Mfg. Co., Collingdale, Pa.

Circle 208, inside back cover.

Bobbinless Resistors—Leaflet, 2 pp, describes small-size, bobbinless, noninductive, wire-type resistors. Includes tolerances and information on sealing of ceramic tubes, resistance wire terminals and a table listing typical sizes and resistances available. Monson Mfg. Corp., 6059 W. Belmont Ave., Chicago 34, Ill.

Circle 209, inside back cover.

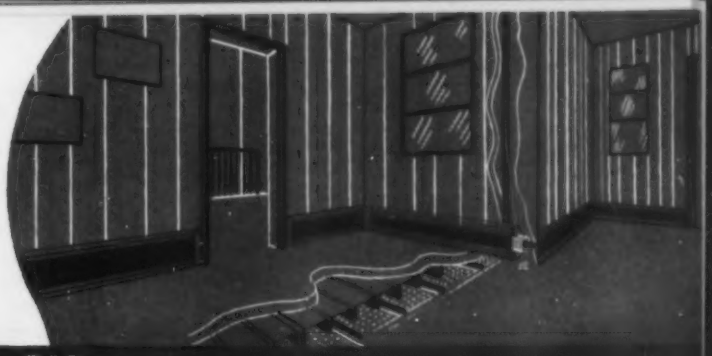
Gas Burning Equipment—Catalog 55, 31 pp, illustrates and describes burners, furnaces, valves, torches, mixers, blowers and water warmers for hardening, tempering, annealing and other such operations. Johnson Gas Appliance Co., Cedar Rapids, Iowa.

Circle 210, inside back cover.

Motor-Alternator—Leaflet, 1 pp, describes synchronous 420 cycles-per-second motor-alternator. Electric Motors & Specialties Inc., King and Hamsher St., Garrett, Ind.

Circle 211, inside back cover.

Steel Handles and Clips—Handbook, 20 pp, contains full-size illustrations



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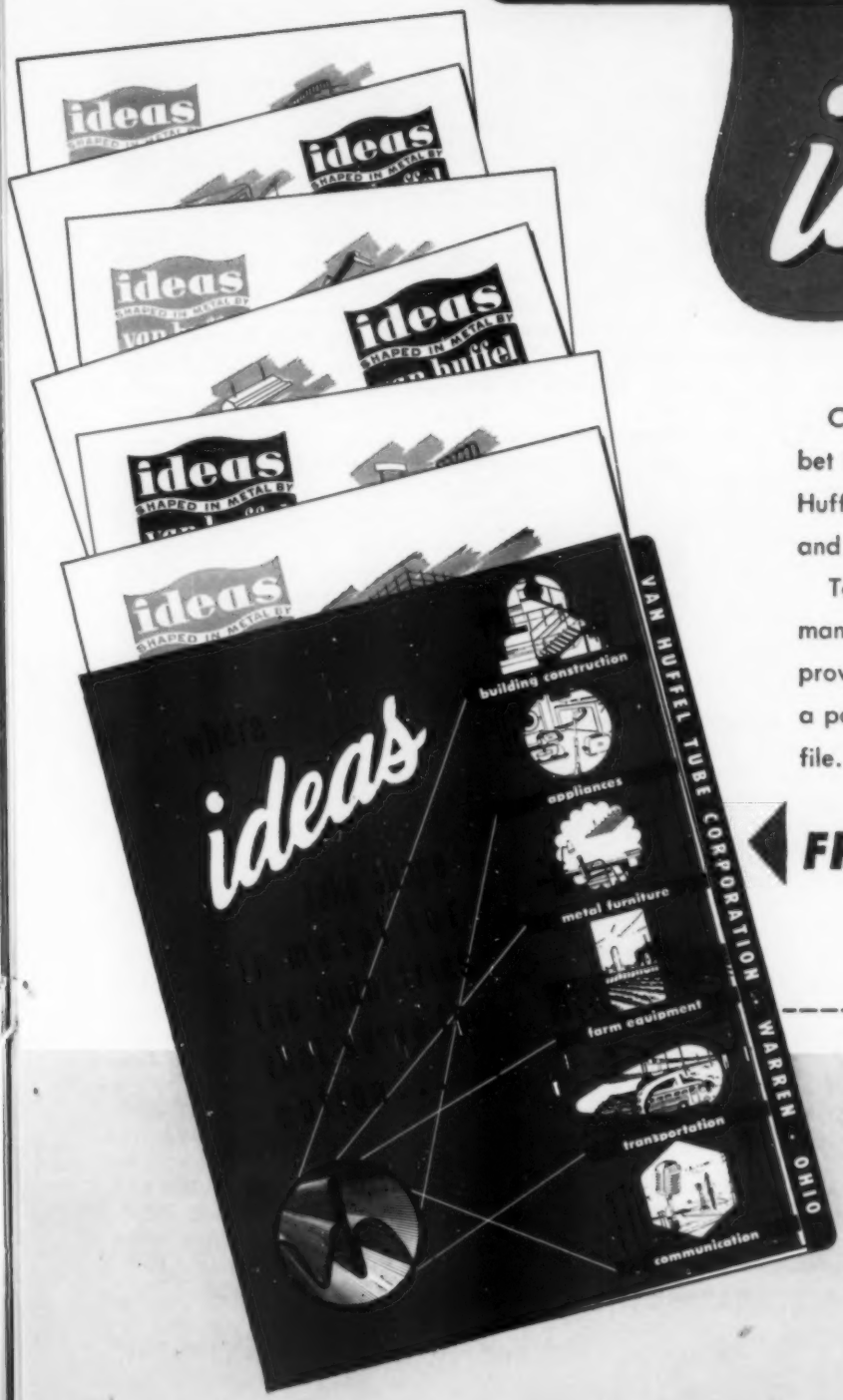

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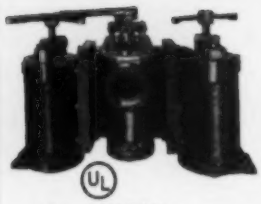

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of 73 different styles and types of standard handles and clips, and provides information and suggestions concerning the design or purchase of handles. Also included is a wire size chart showing actual diameters of standard wire gauges. E. H. Titchener & Co., Binghamton, N. Y.

Circle 212, inside back cover.

Portable Hardness Tester—Brochure F 1689-2, 2 pp, presents data on a hardness tester for aluminum, aluminum alloys, copper, brass and other materials, including plastics. Hardness reading is instantly indicated on dial as instrument is lightly pressed against the material. Barber-Colman Co., 1200 Rock St., Rockford, Ill.

Circle 213, inside back cover.

Vibration Damping Equipment—Catalog 701, 8 pp, explains how vibration damping units can be designed and manufactured for specific applications, from refrigeration equipment to giant punch presses. General Tire & Rubber Co., Wabash, Ind.

Circle 214, inside back cover.

Piston-Type Relief Valves—Catalog sheets, 2 pp, contain detailed cross-section drawing of product, a diagram illustrating its use in a typical circuit, and charts listing operating features. Fluid Controls, Inc., 1284 N. Center St., Mentor, Ohio.

Circle 215, inside back cover.

Remote Adjustable Thermostat—Bulletin F. 4340-1, 2 pp, presents data on thermostat designed for on-off temperature control of aircraft combustion heaters. Barber-Colmon Co., 1200 Rock St., Rockford, Ill.

Circle 216, inside back cover.

Electrical Ceramics—Folder, 4 pp, contains double-spread table of various ceramic materials used in electrical components. Water absorption rates, densities, strengths, resistivities and other significant properties are all given. General Ceramics Corp., Keasbey, N. J.

Circle 217, inside back cover.

Steel Chain—Bulletin, 4 pp, has data on chain for load binding and tie-down, agricultural implements, towing, tail-gates, logging, railroad use. Also includes specifications and working load limits for alloy steel chain especially manufactured for lifting purposes. Joseph T. Ryerson & Son, Inc., Box 8000-A, Chicago 80, Ill.

Circle 218, inside back cover.

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Aluminum Alloys and Mill Products—1954 Data book, 220 pp. A table of contents, a 2-pp index of tabular matter, and a 20-pp itemized cross index with references both to text and tabular information are provided. First few pages discuss the wrought aluminum alloys, their nomenclature and heat treatment. Next, forty-three different aluminum mill products are defined and their manufacture described. A section on fabrication then briefly covers blanking, forming, drawing, spinning, machining, forging, welding, brazing, soldering, riveting, surface finishes; casting methods, foundry practices are described with definitions of 17 aluminum pig and ingot products used in the foundry. Next section is devoted to physical properties and the atomic and radioactive properties. Here half-life and thermal neutron absorption cross sections are discussed. Reynolds Metals Co., 2500 S. 3 St., Louisville 1, Ky.

Multi-V Belt Drives—Handbook, 76 pp, contains a guide to the design of standard and high-capacity drives. New horsepower rating tables that are included are said to closely approximate actual operating conditions. The tables cover speed ratings from 100 to 6,000 fpm. Other subjects covered in the new handbook include: selection of correct multi-V drives, installation and care, principles of design, selection of pre-engineered drives, designing a standard drive not in pre-engineered tables, designing V-flat drives, multi-V quarter turn drives and double-V belt drives. A multi-V belt drive calculation sheet is also included. A series of 22 simplified tables cover such aspects of V-belt engineering as installation and takeup allowance, belt speeds, length correction factor, calculation of center distance and a geometry chart. B. F. Goodrich Co., Akron, Ohio.

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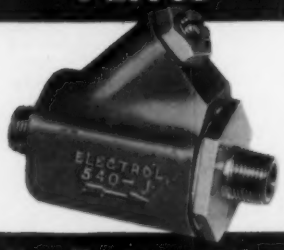

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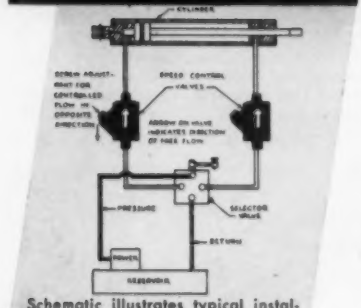

Schematic illustrates typical installation of Electrol Speed Control Valves.

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COMING EVENTS

OCT. 11-15

AIEE Fall Meeting at the Morrison Hotel, Chicago, Ill. Special emphasis will be on the electrical aspects of air transportation. The Power Div. will have sessions on: insulated conductors; protective devices; relays; rotating machinery; switch gear; and system engineering. The Industry & General Applications Div. will sponsor sessions on: Electro Thermal Applications; Feedback Control Systems; General Industry Applications; and others.

OCT. 14-15

Industrial Hydraulics National Conference, Sheraton Hotel, Chicago, Ill. Sessions will be on: automotive applications; presses; pumps; aircraft; components; machine tools; materials handling; pneumatics; and fluids. The meeting is sponsored by the Illinois Institute of Technology Graduate School, and Armour Research Foundation. Conference director is Carl E. Schmitz, V. P., Crane Packing Co.

OCT. 18-19

Lubrication Conference, Lord Baltimore Hotel, Baltimore, Md. Sponsored by the ASME and The American Society of Lubrication Engineers. Five sessions on: Rolling Element Bearings; New Developments in Hydro-dynamic Lubrication; Bearing Instability; Hydrostatic Bearings; and Materials and Lubrication.

NOV. 1-5

National Metal Congress and Exposition. The International Amphitheatre, Chicago, Ill. will house the Exposition, which will be occupied by 444 firms. The Congress will be held in the headquarter hotels of participating Societies: American Society for Metals, Palmer House; American Welding Society, Hotel Sherman; AIME, Morrison Hotel; Society for Non-Destructive Testing, Morrison Hotel. Sponsor is the American Society of Metals, 7301 Euclid Ave., Cleveland 3, Ohio.

NOV. 15-17

The Fifth National Standardization Conference, Hotel Roosevelt, New York City, N. Y. The Thirty-Sixth Annual Meeting of the American Standards Association will be held on the first day. Indications are that: safety; international standards; purchasing; quality control; and color television will be featured.

NOV. 21-22

Automotive Control Equipment Exposition, Waldorf Astoria, New York City, N. Y. The two-day exhibit will be devoted exclusively to the concept of automatic control. Exhibitors will include: instrument and computer manufacturers; firms who design and install complete automatic systems; and manufacturers and designers of components comprising these systems.

NOV. 29-DEC. 2

First International Automation Exposition, at the 244th Regiment Armory, New York City, N. Y. In conjunction with the Exposition, is the Electronic Computer Clinic, which is a lecture and demonstration course on electronic computers, digital and analog, and will offer for the first time, demonstrations and typical applications of different types of computers. The Clinic is planned for top management, management engineers, production engineers, physicists, chemists, and others using computers in the laboratory or plant. Registration fee for this is $5.00. Contact Richard Rimback, Electronic Computer Clinic, 845 Ridge Ave., Pittsburgh 12, Pa.

NOV. 28-DEC. 3

American Society of Mechanical Engineers, Annual Meeting, Hotel Statler, New York City, N. Y. Over 100 technical sessions are planned by the various divisions of ASME, with the following already listed: Process Industries, 2; Aviation, 9; Rubber and Plastics, 4; Heat Transfer, 9; Textile Engineering, 2; Machine Design, 8; Railroad, 5; Metal Processing, 5; Gas Turbine Power, 7; Power, 8; Applied Mechanics, 9; Metals Engineering, 3; Production Engineering, 4; Hydraulics, 6; Instruments and Regulators, 3. In addition, the American Rocket Society will have four technical sessions.

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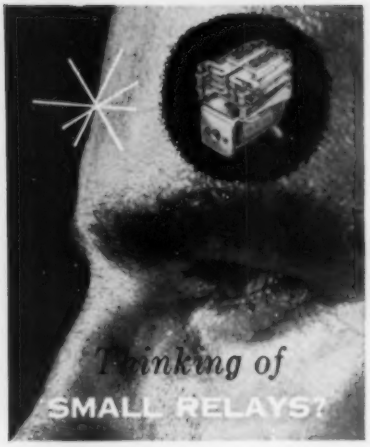

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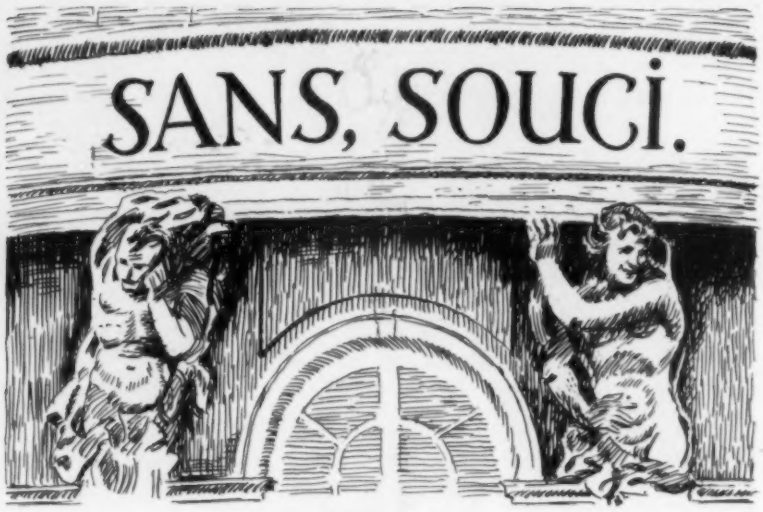


Ad Libbing by the Editor

In this month's editorial we talk about that figure in history known as Alexander the Great. As the editorial points out, Alexander of Macedon was not great in the true sense of that word. But in my life there was another Alexander who had many fine qualities and outstanding abilities. He was more than "a great guy." He was truly a great man. His name was Alexander Steele Lyman.

For more than twenty years Alexander Steele Lyman was general counsel for the New York Central Railroad. Indeed, he had acquired a tremendous reputation as an able lawyer for his handling of the Park Avenue viaduct damage cases that were brought against the New York Central Railroad as a result of the building of the viaduct. He sat down with the people who presented their damage claims and discussed with them both sides of their case. Then there followed considerable give and take and finally the whole matter was settled to the satisfaction of both parties without recourse to court litigation. Not one case went to court.

This accomplishment was not surprising to those people who knew Alexander Lyman. He was a man of great personality and dignity. He was also a great humanitarian. He planned and founded the New York Central Railroad Veterans Association. He also served as Chairman of the Board of Managers of the Railroad branch of the Y.M.C.A. He was extremely active in the Alumni Association of New York University from which he was graduated in 1884. He served on the New York University Council. He also loved to counsel boys and that is how I came to know him.

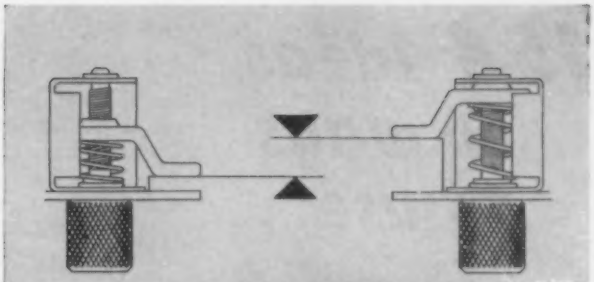
Whereas Alexander of Macedon tried to reach his personal objectives by might without hesitating to kill, plunder, devastate and breed hate, Alexander Lyman taught Christian principles and brought harmony out of discord, agreement where disagreement had existed and leadership where that was lacking.

One of the many thought-provoking things that Alexander Lyman had said was that, "It is more important to know how people greet each other than to know the names of generals and the dates of the battles they fought." In other words, the cultural and spiritual achievements of humanity are far more valuable than victorious military campaigns and battles. Hero worship can easily cause us to laud what should be condemned and ignore the truly laudable. As stated in the poem, The Battle of Blenheim, by Robert Southey, in which the grandfather describes the battle to his granddaughter Peterkin:

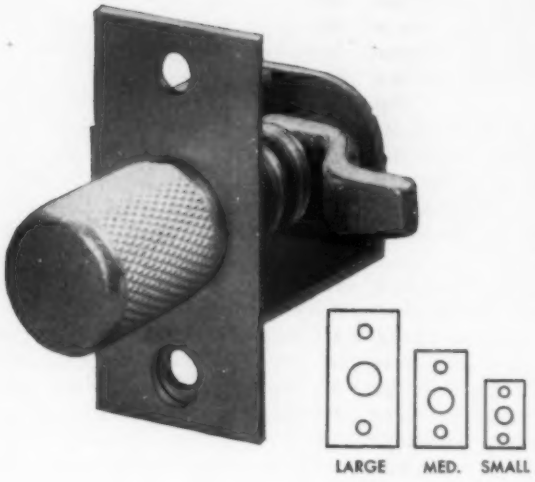
" 'And everybody praised the Duke
Who this great fight did win.'
'But what good came of it at last?'
Quoth little Peterkin.
'Why, that I cannot tell,' said he,
'But 'twas a famous victory.' "

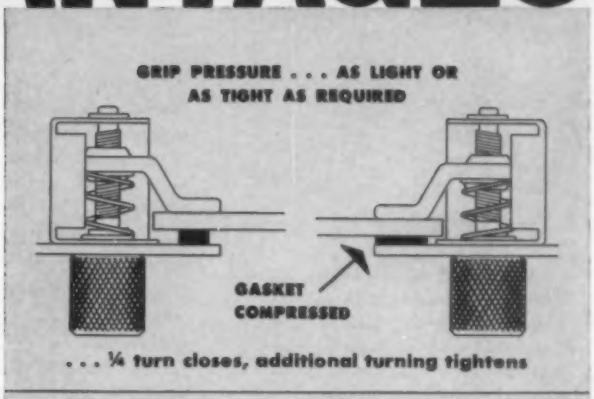
Coming back to human beings worthy of honor, I remember that I went through a four year undergraduate course in engineering without ever knowing that Newton and Leibnitz

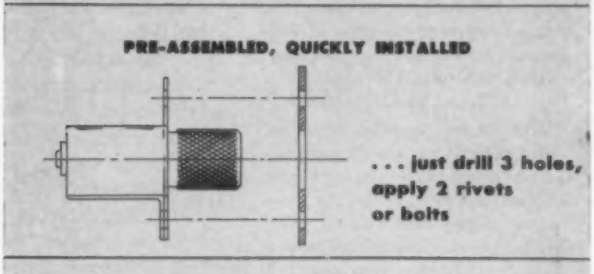
a family of door fasteners with

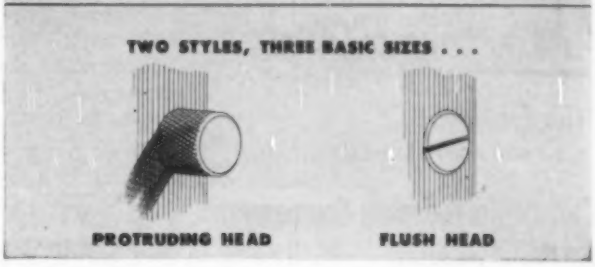


BIG ADVANTAGES









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had invented calculus independently and at about the same time. I memorized the derivation of the Carnot Cycle Efficiency but didn't even know that Carnot's first name was Sadi nor that he was a poet rather than a physicist. Rudolph Diesel was alive at the time so the newspapers gave me a little information about him. But as far as Faraday and Watt are concerned, their names were hardly mentioned, except perhaps as electrical units. I knew much more about Hannibal crossing the Alps, the campaigns of Julius Ceasar, Napoleon's march into Russia and so on down through the pages of history.

We are always likely to become completely unbalanced regarding the relative importance we attach to different human activities and human relationships. Here again I still remember a mightly interesting session a group of us boys had with Alexander Lyman. It was a great lesson and I will never forget it.

There were about a dozen of us, 16 or 17 years old, sitting around and listening carefully. He was a past master at asking simple questions and answering the question in even more simple terms.

On the particular occasion that I have in mind, Alexander Lyman asked, "What is the most important part of a steamship?" Now all of us fellows were quite familiar with tug boats and steamers. We lived near the water front and played around on ships and associated with crew members. Frankly, we were not so conceited that we thought that we could tell this railroad lawyer something he didn't know about ships. But on the other hand, we felt quite certain that he couldn't ask us anything about a ship that we didn't know. So there was an enthusiastic chorus coming from the group, various individuals volunteering:

"The engine" — "The rudder" — "Compass" — "The propeller", and so on. Alexander Lyman smiled faintly and said, "All of you have answered the basic question. All of you are correct, even though each of you gave a different answer. The engine is a highly complicated, ingenious and expensive piece of machinery and the boat cannot move without it. The rudder and its controls is quite a mechanism, considerably simpler and less costly than the engine but without it the direction of the ship cannot be controlled. The propeller with its beautiful curved vanes is needed to send the ship forward or backward. The propeller shaft is nothing much more than a bar of steel that the engine pushes around continuously. But if that bar of steel breaks it will be just as disastrous as if the propeller fell off, the rudder broke or the engine failed.

"It is only too easy for a person to feel that he is a mere cog of no account except to be pushed around like a propeller shaft. But although he may be the youngest of the group, the least skilled and the least educated, that man may be just as important as the biggest boss in the organization insofar as the operation of that business is concerned. It is the old, old story. For the want of a nail the shoe is lost, for the want of a shoe the horse was lost and thus the battle was lost.

"The battle was not lost because the horse tripped and fell. A mere horse shoe nail had decided the battle.

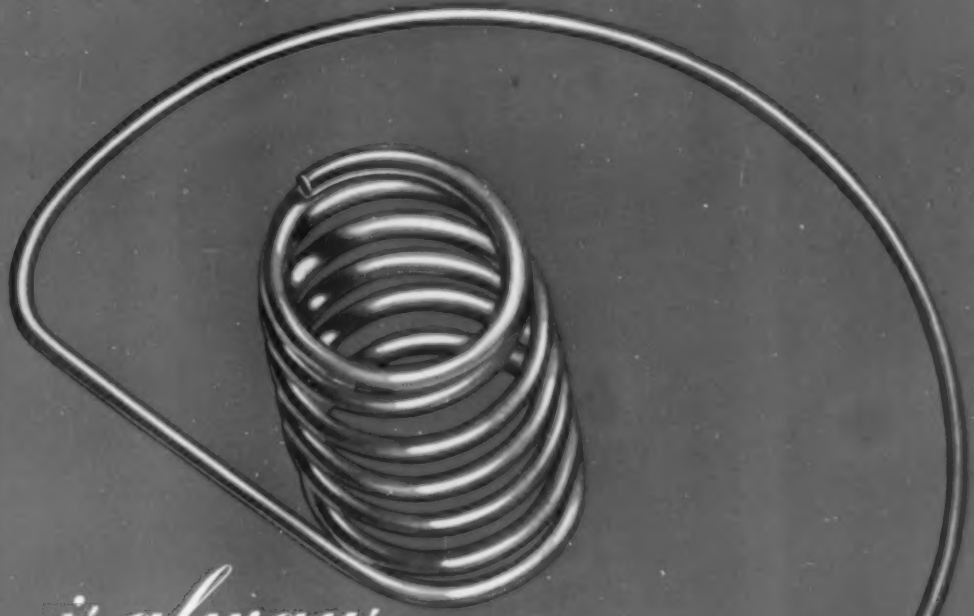
"Thus you see, boys, you should never underrate yourself. Maybe today you are only a propeller shaft being pushed around, or a horse shoe nail, yet victory or defeat or the fate of society might be depending on you, if not today then perhaps in the years to come. You too are important but you must prepare yourself and make yourself worthy of your importance."

How we young kids drank in those words, the words of an Alexander who was really great as measured by his contributions to better human understanding and fellowship. —G.F.N.

Our First 25 Years

January, 1955, marks the beginning of the 26th year of continuous service by Product Engineering to the professional and product development interests of design engineers. A special staff-written feature article in this coming January issue, commemorating our first 25 years of publication, will present a survey of basic research developments that promise to influence future product design. Significant projects in all major industrial, government and institutional research laboratories are now being evaluated.

a SPRING



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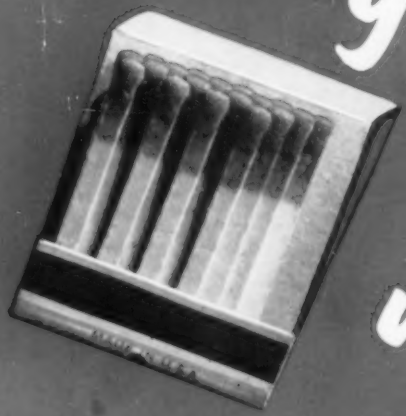

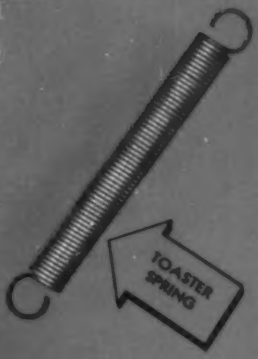

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NEW BOOKS

Plastics Engineering Handbook

Society of the Plastics Industry, Inc., 852 pp., 6 x 9 in., published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. $15.

This is the second edition of the Handbook of the Society of the Plastics Industry, Inc., and covers the developments in that industry in the seven years since the first edition appeared.

The Handbook is divided into five major sections. Section I deals with materials and processes and includes the classification of all the rigid molding materials along with a comprehensive coverage of the molding process as it applies to plastics. Preforming, drying and preheating operations are described, as well as the equipment required for these procedures. Space is also given to the other fabricating processes such as extrusion, forming, drawing and post-forming, along with a description not only of the process, but of the equipment required. Section I also includes a sub-division on reinforced plastics and takes into consideration the casting operations as they pertain to the plastics industry. A new sub-division entitled Tooling With Plastics describes this new use of plastics thoroughly. Embedding, vinyl dispersions and laminated products conclude this section.

Section II is devoted to design problems and starts out with a discussion on the design of molded articles and continues with standards for tolerances on molded articles. Design standards for inserts, mold design and recommended steels for plastic molds are also included.

Section III covers finishing and assembly and takes into consideration those secondary operations such as machining, finishing and decorating along with cementing, welding and assembling. There is a detailed discussion of assembly gluing which is valuable to the fabricator planning to use plastics.

Section IV is short and is headed "Testing". This describes the various testing operations for plastics articles

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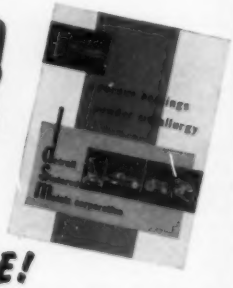

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so that the properties of the material in the product can be determined. It includes destructive testing as well as non-destructive testing. The last section deals with the Society of the Plastics Industry Standards, and outlines the voluntary commercial standards set forth by the plastics industry.

The Handbook is well illustrated and contains a number of reference charts and figures which make the book a valuable one from the standpoint of anyone connected with the plastics industry. It is nearly twice the size of the first edition and reflects the growth of the industry, as well as the new processing and the new applications for which plastics lend themselves. One of the important innovations included in this Second Edition is the special fold-out adhesives chart, found in the chapter on cementing and assembly. This chart, compiled from questionnaires returned by producers of adhesives all over the country, is a complete tabulation of the types and characteristics of adhesives used to join plastics to each other or to other materials.

Manual for Plastic Welding - Polyethylene

G. Haim, *Rediweld, Ltd., Crawley, Sussex, England, and* J. A. Neumann, *American Agile Corp., Bedford, Ohio.* 6 x 9 *in.*, 125 *pp. Published by the Industrial Book Co., 1240 Ontario St., Cleveland, Ohio.* $6.

This is Volume II in a series of three on the welding of plastics. At the present time, there are two distinct trends in the welding of plastics: gas welding, mainly applied to structural work; and high-frequency welding, mostly used for household goods, toys, and fancy articles from plasticized PVC sheets. This book is confined to gas welding of polyethylene and its various structural applications.

The first part of the book is devoted to a description of the various types of polyethylene, their physical and mechanical properties, chemical resistance and forms in which they are available. A discussion of the design principles of extrusion machinery and recommendations for their incorporation into custom-built equipment is also included.

The latter part of the book covers the practical aspects of gas welding in sufficient detail to be of excellent use to the man who wants to become a plastic welder. The construction and operating principles of gas plastic welding torches are described, including both electric and flame gas-heating torches. The methods and techniques of welding and use of polyethylene welding rod are treated extensively. "How-to" instructions in the lining of tanks, fabrication of pipe lines, and other structural assembling operations are also included. The book is well illustrated throughout.

Analog Methods in Computation and Simulation

Walter W. Soroka, *Professor of Engineering Design, University of California.* 6 x 9 *in.*, 390 *pp., published by McGraw-Hill Book Co., Inc.*, 330 W. 42*nd St., New York* 36, N. Y. $7.50.

The term *analogy* means simularity of properties or relations without identity. When analogous systems are found to exist, measurements or other observations made on one of these systems predict the behavior of other more complex systems. The systems need not be analogous in every respect, but only in those respects which are of interest. In this book, the analogies between systems is developed on the basis of simularity of equations. Thus, it serves as a guide to those interested in solving complex engineering problems with the help of automatic computing machines.

Analogies are developed for the various arithmetical processes such as addition, multiplication, and integration. Mechanical, electromechanical, electrical and electronic computing elements that perform these processes are discussed and illustrated in detail. These basic analogies are then combined into analog computers for linear simultaneous algebraic equations, polynominal equations, and ordinary differential equations. The mechanical differtial analyzer and the electronic analog computer are discussed in this connection.

The dynamical simularity between electrical circuits and mechanical systems is taken as the basis for representing mechanical systems in lumped form by equivalent electrical circuits with lumped parameters. Then, ordinary and partial differential equations

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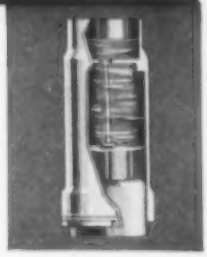

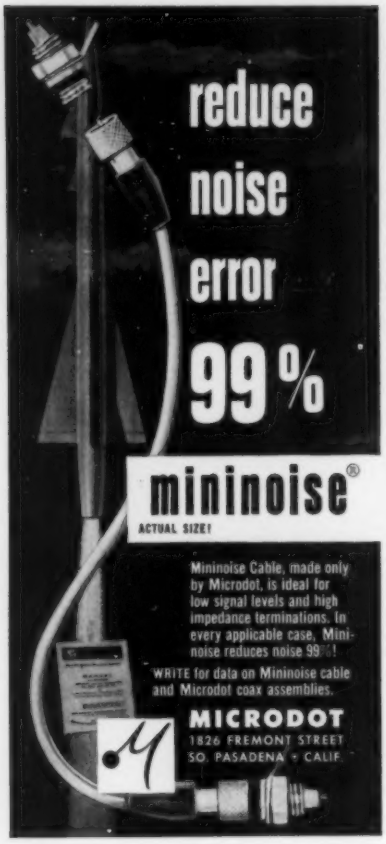
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of various degrees of complexity, linear and non-linear are expressed in finite differences and electrical networks are developed for their solution. The author concludes with a chapter devoted to a study of membranes and of electrically conducting sheets as simulating devices for continuous systems.

Rare Metals Handbook

Edited by CLIFFORD A. HAMPEL, *Chemical Engr., Homewood, Ill. Formerly Supervisor, Extraction Metallurgy, Armour Research Foundation, Chicago, Ill.* 6 x 9 *in.*, 657 *pp. Published by the Reinhold Publishing Corp., 430 Park Ave., New York, N. Y.* $12.

This book has been designed to accomplish the following purposes: (1) to bring together for the first time the available reference data on over 34 rare or uncommon metals—the latest methods of production from ores or other raw materials, the chemical and physical properties, fabrication techniques and present and potential uses.

(2) To offer an authoritative, concise and readily available background to the man who desires information about a specific metal or metals, and at the same time to give him selected bibliographical reference to enable him to conduct a more detailed research if he so desires.

(3) To provide a convenient source of data for the man who has a general question, such as "What metals have melting points over 1,000 C and densities below that of steel?"

The treatment has been limited to emphasis upon the metallic or elemental form with only a minor presentation of material about compounds. The list of metals selected for inclusion covers most of the less common metals about which there is an expanding interest. While there may be debate of an academic nature as to whether elements like boron and silicon are metals, they do exhibit some of the properties commonly regarded as characteristic of metals, and the growing interest in them in several fields of metallurgy warrants their inclusion in this book.

As pointed out in the final chapter, it so happens that cost alone is a worthy basis for regarding a given metal as rare or common. A classification of metals in order of increasing price per pound reveals that of the first 13 only one of the metals included in this book, manganese, appears among them. Also, of the metals not covered in this book, only mercury, silver, and gold appear further down the list. This is not surprising since cost is a good measure of the availability and scope of usage of a metal regardless of the relative rarity of raw materials, complexity of processing, etc. for the production of a metal in commercially attractive form.

The designation, "Rare Metals," was chosen as being simple and not misleading as compared with other names considered, i.e., "Less Common Metals," or "Unusual Metals" or even "Extraordinary Metals." It suffers from a certain amount of inaccuracy, of course, but the term is such that most people in the field will know exactly what group is meant to be covered by the phrase "Rare Metals." The long use of the term by such pioneers as Drs. John W. Marden and Colin G. Fink in the symposia of the Electrochemical Society, where many of the original reports of the isolation and properties of these metals have been presented, was a major factor in choosing the name for the "Rare Metals Handbook."

Fiberglas Reinforced Plastics

RALPH H. SONNEBORN, *Technical Service Department, Plastics Reinforcement Division, Owens-Corning Fiberglas Corporation and others.* 240 *pp.* 5¼ x 8½ *in. Published by Reinhold Publishing Corporation, 430 Park Ave., New York, N. Y.* $4.50.

This book represents the first complete work to be published on the subject of reinforced plastics. Starting with a definition of this relatively new engineering material, the author continues with a description of the properties of the raw material used in the production of reinforced plastics.

A complete description of the manufacturing processes for Fiberglas reinforced plastics with an analysis of each is included as well as a similar treatment for such secondary operations as machining, fastening and painting. A chapter on inspection and testing tends to round out the production process for reinforced plastics.

Considerable coverage is given to designs and applications, and the au-

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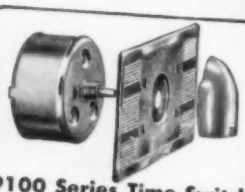

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thor has included two important chapters on design by contributing authors to supplement his own work. Design theory of reinforced plastics by Albert G. H. Dietz, head of the Department of Structural Materials at MIT, includes such items as the theory of combined action as it applies to Fiberglas reinforced plastics and an analysis of the mechanics of materials as it applies to plain reinforced plates, composite plates, bending of beams and plates, plate and rib construction and sandwich constructions. Alton S. Heyser, staff engineer, Reed Research, Inc., Washington, D. C., contributes the final chapter on structural design.

A glossary of terms as applied to reinforced plastics and a selected bibliography will serve to make the book interesting for design engineers and executives in the materials industry. The book contains many illustrations of the material and process, and pictures of a number of applications.

Alternating-Current Machines

Third Edition. A. F. Puchstein, *Consulting Engineer, Jeffrey Mfg. Co.*, T. C. Lloyd, *Chief Engineer, Robbins and Myers, Inc.*, and A. G. Conrad, *Professor of Electrical Engineering, Yale University.* 6½ x 9¼ *in.*, 721 *pp. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.* $8.50.

The third edition of this book has been enlarged approximately 20 percent and it offers an unusually complete treatment of machine reactions based on modern practice. "Alternating-Current Machinery" is a standard college text devoted to transformers, alternators, single and polyphase induction motors, synchronous motors, alternators in parallel, synchronous converters, mercury vapor rectifiers, single-phase commutator motors, and repulsion motors. Each subject is treated by a discussion of the construction, operating characteristics, calculation of operating characteristics from tests, and analyses of various related phenomena. Beginning with the transformers, this book explains how to understand, test, predict, and calculate the behavior and performance of the classes of alternating current machinery described in the text.

Although rigorous in the treatment of machine reactions, the book provides expressive self-identifying terms, notations, and symbols. A diverse set of up-to-date problems has been incorporated to provide a student with an understanding of various theoretical applications of the machinery. A portion of the new material includes information on leading polyphase transformers, adjustable speed drives, short-circuit characteristics of alternators, and rectifiers. The authors have projected a new approach to the development of all equivalent circuits, and they describe significant changes in the more detailed developments of vector diagrams, the equations describing the oscillations of synchronous motors, and the methods of calculating the cross-axis voltages of synchronous machines.

ASTM Standards on Materials For Radio Tubes and Electronic Devices and Electrical-Heating, Resistance, And Related Alloys

6 x 9 *in.*, 244 *pp.*, *paper-bound. Published by the American Society for Testing Materials*, 1916 *Race St., Philadelphia* 3, *Pa.*, $2.75.

This is a good reference for Engineering Standards and Quality Control personnel, as well as good background material for design engineers.

Contents include latest standard specifications for: (1) electrical-heating alloys, (2) electrical-resistance alloys, (3) electric-furnace alloys, and (4) materials for radio tubes, electronic devices and lamps.

Latest standard test methods are also given to determine the extent to which these and other materials (namely, (1) heat-resisting alloys, (2) electrical contact materials, and (3) thermostat metals) meet the standard specifications. Several recommended practices for tension tests of heat-resisting alloys are also included.

Material not previously published includes: specifications for circular cross-section nickel cathode sleeves for electronic devices, 17 and 28 percent chromium-iron alloy for sealing to glass, high-resistivity, low-temperature-coefficient wire, and round chromium-copper wire for electronic devices; test methods for sag of tungsten wire, relative thermionic emissive properties of

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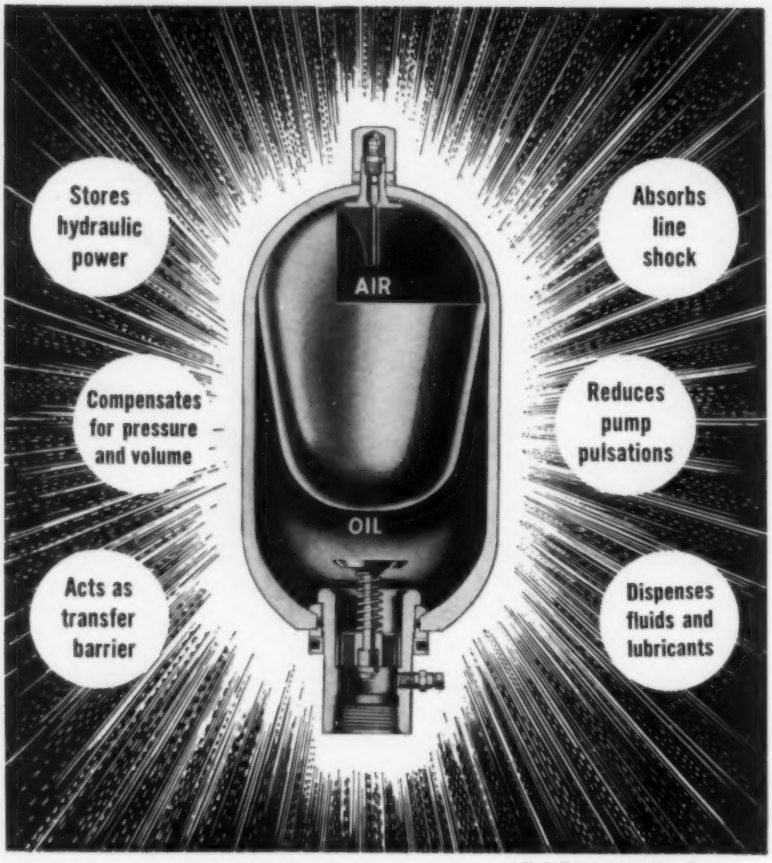

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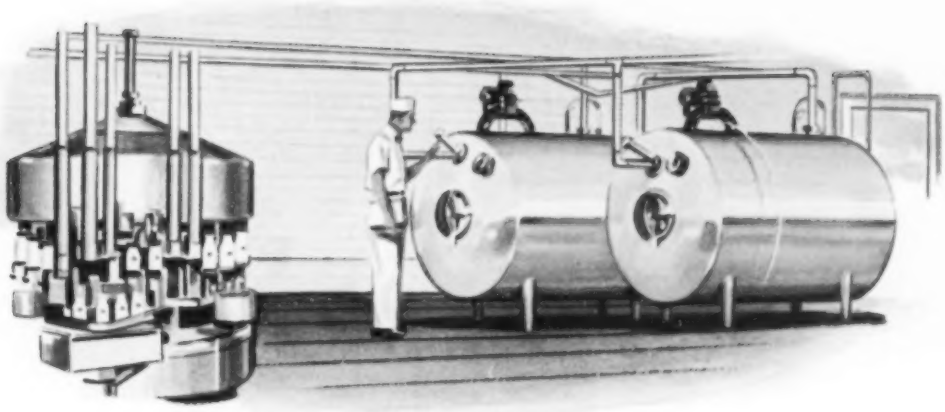
Millimicrosecond Pulse Techniques

IAN A. D. LEWIS, *Senior Scientific Officer, General Physics Division and* FRANK H. WELLS, *Principal Scientific Officer, Electronics Division, Atomic Energy Research Establishment, Harwell, England.* 6 x 9 *in.*, 309 *pp. Published by McGraw-Hill Book Co., Inc.*, 330 *West* 42*nd St., New York* 36, *N. Y.*, $7.50.

Published jointly with the Pergamon press of London, this book is a new addition to the series "Electronics and Waves". "Millimicrosecond Pulse Techniques" covers the theory and design of electronic circuits and devices for operation in the region in which pulses of 10^{-6} and 10^{-10} seconds are used. Systems of large bandwidth in the microwave region are the primary concern of the book. In the microsecond region the familiar circuit parameters of resistance, inductance, and capacitance are treated as discrete entities since the linear dimensions of the components are much shorter than the wavelength of electromagnetic radiation corresponding to the highest frequency components involved. In the microwave region the importance of linear dimensions is stressed. Conventional pulse circuits, embodying lumped circuit elements are pushed to the limit of their response, and arrangements in which the circuit parameters are deliberately distributed in space and which possess wave propagation characteristics are also described.

Theoretical principles and practical techniques are combined in this text which includes the most up-to-date material heretofore available only in widely scattered periodicals. A discussion of the simple Laplace transform treatment of a transmission line, an account of tapered line transformers, and some heretofore unpublished circuits used in nuclear physics are covered in detail. A short Bibliography and a comprehensive list of refences complete the volume.



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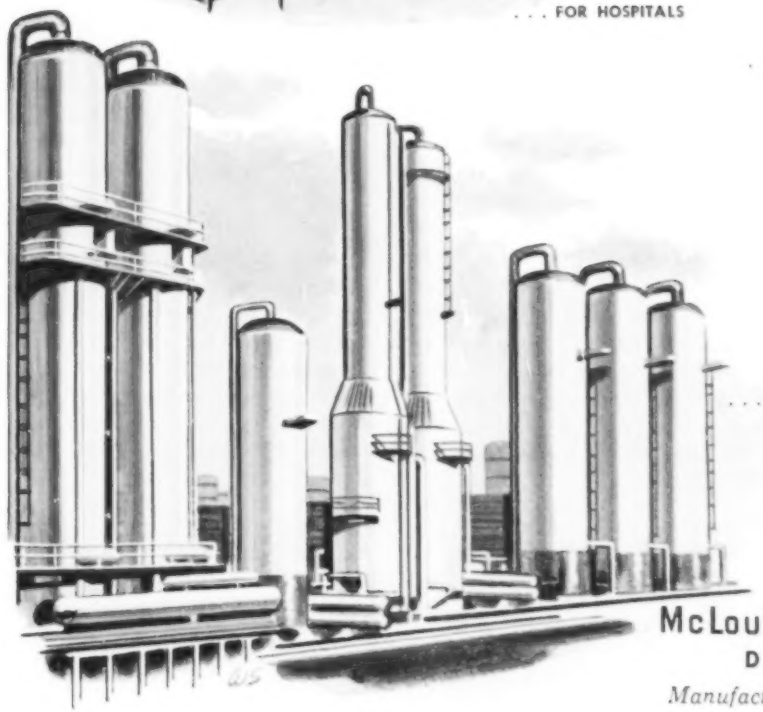

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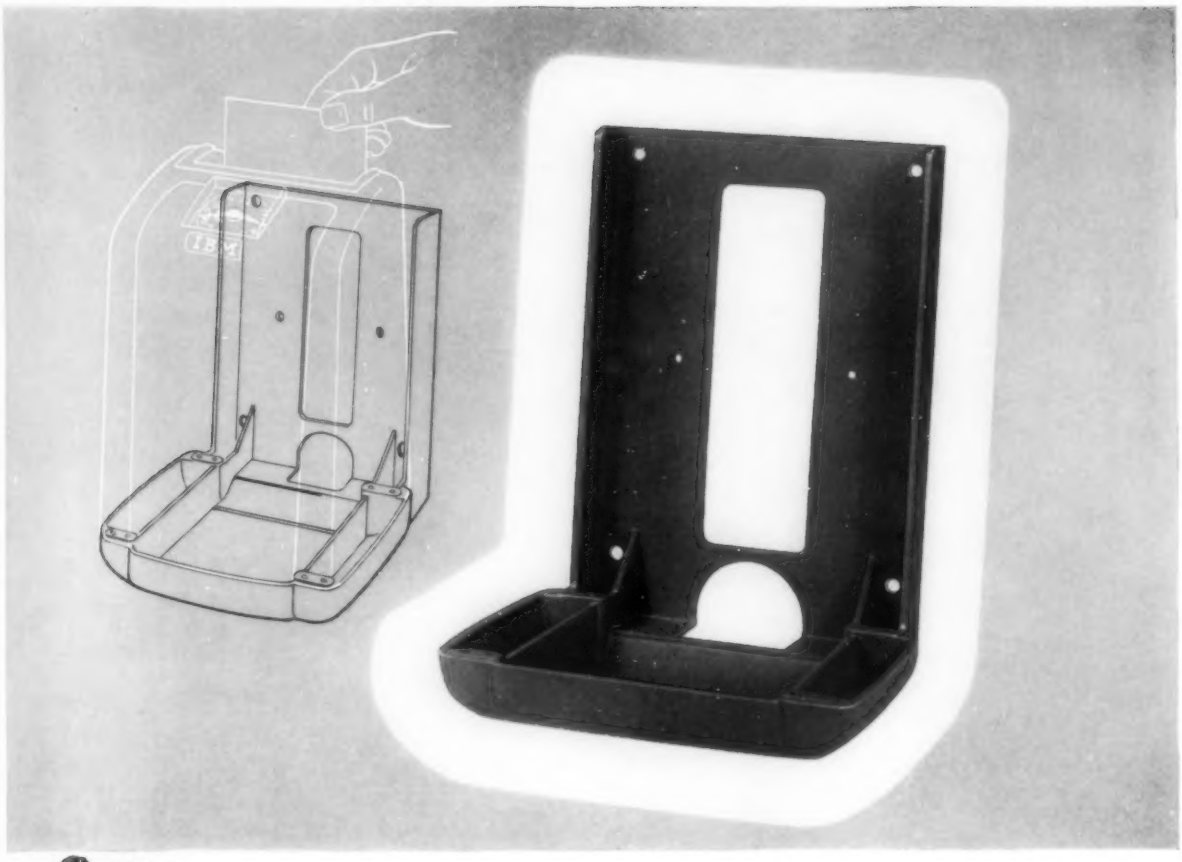

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ENGINEERING ABSTRACTS

Bonding Adhesives

Abstracted from "Adhesive Bonding Complements Soldering and Brazing," by H. H. Simmons, Eutectic Welding Alloys Corp., Flushing, N. Y., *Welding Journal*, July 1954, P. 647.

The organic materials from which almost all adhesives are compounded fall into four groups: synthetic thermoplastic, synthetic thermosetting, rubber-base and protein. Adhesives are further classified according to the manner of use, as determined by physical form and chemical properties.

The bonding classifications are:
(1) Solvent Release. The adhesives in this class are those dispersed in a volatile solvent. Release of solvent is necessary to prepare the joint and can be achieved by air drying or with heat.
(2) Fusion. This class of adhesive is used in solid form as a powder, film or rod. Heat is required to produce the bond and the adhesive is either preplaced into the joint area or caused to flow into the joint while molten.
(3) Cured. The adhesives in this class complete the bond through a chemical or polymerization reaction. Bonds are made at room temperature or with heat. Curing time will vary from 24 hr at room temperature to minutes at elevated temperatures. These adhesives are available in 100 per cent liquid resin form, solvent, paste and solid. When obtained in solvent form, the solvent may enter into the reaction. When the solvent does not enter into the reaction, a solvent release procedure must be followed in addition to the curing schedule.
(4) Vulcanization. This bonding method is confined exclusively to the rubber base adhesives, and can be considered as a special case of the cured type of bonding. Rubber base adhesives are obtained in solvent or solid form.

Thermoplastic Adhesives

Chemical Types: (a) Cellulose derivatives; (b) acrylic esters; (c) vinyl resins; (d) styrene resins; (e) alkyd resins; and (f) polyamide resins.

Characteristics: The temperature at which these adhesives lose strength will, of course, depend upon the softening point of the material. Fungus resistance of this group is excellent; resistance to heat, cold, water and solvents is variable.

The materials in this group find their greatest use for nonmetallic bonds, particularly paper, textiles and wood. With the exception of several vinyl resins and the polyamide, bonds on metals are poor. The adhesives in this group are in either the solvent release or fusion class.

Thermosetting Adhesives

Chemical Types: (a) Phenol resins; (b) resorcinol resins; (c) furane resins; (d) amino resins; (e) polyester resins; (f) silicone resins; and (g) epoxy resins.

Characteristics: The bonds in these adhesives are stronger over a wide temperature range than the thermoplastic adhesives. Resistance to heat, cold, water and solvents is uniformly high and superior to the thermoplastic adhesives. This group is the more versatile for use on nonmetals. In addition, a large number give high-strength bonds with metals. The types most suitable for metals are the epoxies, silicones, phenolic polyamide and phenolic acetal compounds. The adhesives in this group are in the cured class.

Rubber-Base Adhesives

Types: (a) Natural rubber; (b) neoprene rubber; (c) reclaimed rubber; (d) butyl rubber; (e) thiokol; (f) cyclized rubber; (g) chlorinated rubber; (h) butadiene acrylonitrile; and (i) silicone rubber.

Characteristics: The bonds in this group can be either thermoplastic or thermosetting. The strength at elevated temperatures will therefore fall between the thermoplastic and thermosetting adhesives. Solvent, heat, cold and water resistance is also intermediate between the two types. Bonding is good with all nonmetallics. The best types for metal bonding are the butadiene-acrylonitrile, thiokol and silicone rubbers.

Protein Adhesives

Types: (a) Casein; (b) animal glue; (c) zein; and (d) soybean glue.

Characteristics: These adhesives are

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more usually classed as glues and their use limited to special applications. They are all water soluble; seldom used for joining metals.

Effect of V and Mo On Mn Cast Steel

Abstracted from "Vanadium and Molybdenum in Medium Manganese Cast Steel," by Charles C. Spencer, Melting Supt., Electric Steel Castings Co., Indianapolis, Ind., *American Foundryman*, July 1954.

Medium manganese cast steels exhibiting excellent strength and ductility at medium carbon levels have been produced in large tonnages for many years. These steels are usually made in the range of 1.00-1.60 per cent manganese and 0.20-0.50 per cent carbon. They frequently contain an additional alloying element such as molybdenum, vanadium, or chromium and such combinations as manganese-molybdenum and manganese-vanadium have found wide acceptance in the steel castings industry.

Test work designed to obtain comparative data on physical properties of medium manganese, manganese-vanadium, and manganese-molybdenum cast steels have been made. As a result of this work, it is concluded that in steels of the medium manganese type examined, and in the particular conditions of heat treatment represented, the manganese-vanadium steels containing 0.10 per cent vanadium were equivalent to the manganese-molybdenum steels containing 0.30 per cent molybdenum with regard to mechanical properties and hardenability.

To obtain the physical property data desired on medium manganese, manganese-molybdenum and manganese-vanadium steel castings, a series of keel block ends were cast. To obtain an accurate comparison, the three analyses cast were made from the same heat of steel, by means of ladle additions of vanadium and molybdenum to a medium manganese heat.

Regular melting practice was followed in the production of the heat in which the keel block ends were cast. The heat was melted in a 5 ton, 2,500 kva acid-lined furnace. The charge consisted of 40 per cent shop returns and 60 per cent carbon scrap. Normal melting practice involves oxidation of the heats with the use of both iron ore and oxygen. Carbon is reduced to about 0.12 per cent content and the heat is recarburized with pig iron followed by a furnace addition of silicomanganese and ferromanganese immediately prior to tap. Ladle deoxidation practice consists of the addition of 1 lb aluminum plus 5 lb calcium-manganese-silicon per ton in the tapping ladle, and additions of 1½ lb aluminum plus 2 lb calcium-silicon per ton in the shank ladles.

Keel blocks were poured from each of the four 375 lb shank ladles from the same heat, ladle additions being made as follows: (1) normal shank ladle—aluminum and calcium-silicon additions only; (2) vanadium addition plus normal aluminum and calcium-silicon additions; (3) molybdenum addition plus normal aluminum and calcium-silicon additions; (4) vanadium and normal aluminum and calcium-silicone additions plus a small addition of iron ore.

The iron ore addition to ladle 4 was made to study the effect, if any, of this addition on the ductility of the steel. All shank ladle additions were introduced from a sheet-metal chute into the metal stream from the teapot ladle. Four keel blocks were poured on each of these four ladles and analysis, harden ability data, and physical properties were obtained.

Chemical analyses indicate that good recovery was obtained with all of the ladle additions. The original aim was a vanadium content of approximately 0.10 per cent in ladles 2 and 4 and a molybdenum content of 0.25 to 0.30 per cent in ladle 3.

Metallographic examination of samples from bars of each of the four compositions indicated the predominant inclusion type to be irregular sulfides with occasional duplex sulfides. No significant differences in type or quality of inclusions were observed among the specimens.

Representative bars of the four steels were normalized and water quenched from 1,650 F and drawn at temperatures from 900 F to 1,200 F. Upon testing, it was noted that the addition of 0.11 per cent vanadium to cast steel of the medium manganese type resulted in tensile and impact properties in the normalized and drawn condition similar to those obtained with the addition of 0.31 per cent molybdenum. After quenching and drawing, the vanadium treated steel appeared

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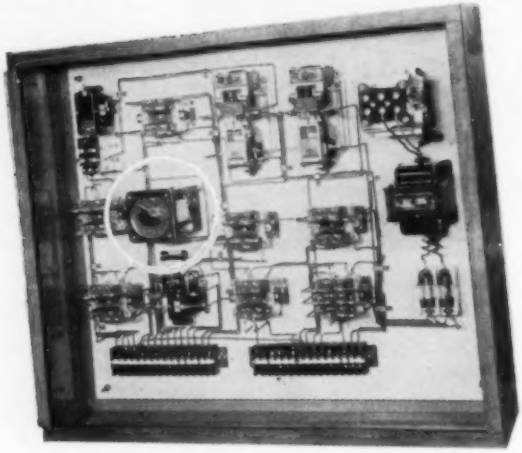

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slightly superior. The addition of iron ore to the vanadium-treated ladle resulted in some loss of ductility in the tensile test of the normalized and drawn specimen. This lower ductility was reflected in the appearance of a fracture, which was "irregular" as compared to at least a "half cup" in all other tests. On the other hand, the impact resistance of this steel was considerably increased. In the quenched and drawn condition, the differences were not so noticeable.

Standard Jominy hardenability tests were carried out on samples from the bars from each of the four ladles. It was noted that the addition of 0.11 per cent vanadium increases the hardenability, particularly the non-martensite hardenability, to a degree at least equivalent to that produced by 0.31 per cent molybdenum. The iron oxide addition to the vanadium treated steel resulted in an even greater increase, however, the mechanical properties of the latter steel were somewhat inferior.

Selecting Lubricating Greases

Abstracted from "Lubricating Grease," by George W. Miller, President, Battenfield Grease and Oil Corp., North Tonawanda, N. Y., *NLGI Spokesman,* June 1954.

Lubricating greases are produced in many types and forms, some very simple in formulation and some highly complex. There is little question as to the versatility or advantage of lubricating grease over straight lubricating oils, when the proper grade or type is chosen and properly applied. Four types are in general use for average lubrication requirements:

(1) Water-resistant type for applications from below zero to approximately 180 F operating temperatures. This classification takes into consideration, calcium and aluminum base greases.

The most important factor in selecting a calcium base grease is that the normal calcium base greases are not safe to use for extended periods of time where operating temperatures will cause rapid evaporation or loss of the water content. Elevated temperatures tend to evaporate the water, which acts as a binder of the soap and oil, allowing the oil to separate readily and bleed from the bearing leaving a heavy, sticky mass of soap which causes difficulty in bearings.

For low temperature lubrication, vis-

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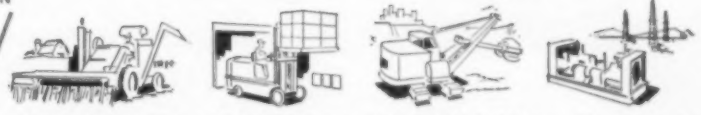

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cosity, VI and pour point of the oil used in the grease are extremely important. Consistency and soap structure follow. The proper type of fat must be used for best results and the water content must be reduced to a trace. Such greases are available for low temperature lubrication, but are not recommended for use where the conditions, although involving a period of very high temperature operation, too, because of possible physical change of the grease due to moisture loss, and extreme thinning and evaporation tendency of the light viscosity oils generally used in this type grease.

Aluminum base greases may have an advantage over some types of calcium greases because there is slightly less tendency for them to bleed oil.

(2) Water-soluble type for applications from average operating temperatures above freezing to temperatures ranging up to 300-400 F and over—generally the soda base greases.

Soda base greases can be used as low temperature lubricants depending upon the viscosity and VI of the oil used and consistency and type fats used to formulate the base. Generally, below freezing and invariably below zero, even with light viscosity oils, soda base greases become very stiff and difficult to pump, creating high starting torques and, in the case of small anti-friction bearings, preventing bearing movement entirely.

Another fact to take into consideration is the general structural appearance, whether a short, buttery type or a long, stringy, fibrous type. It is generally accepted that the short, buttery types of grease are most desirable for anti-friction bearings and general sleeve-type bearing lubrication due to the fact that there is less resistance to shear in the short fibered structure and less breakdown of the grease due to operation of the bearing. For bearings such as coupler type, universal joints, etc. where throw-off due to centrifugal force is a factor, the stringy, long-fibered types are most desirable as the fibers tend to wind around the moving parts and thus resist throw-off.

In using a soda base grease at elevated temperatures, care must be taken to choose grease that will not bleed oil or thicken excessively due to oil evaporation. Therefore, it is necessary to determine the optimum temperature and speed at which a bearing will operate over a long period of time and then choose the grease accordingly. The lighter viscosity and high VI oils have a greater tendency to bleed under operating and storage conditions than the medium or heavy viscosity oils of lower VI.

The difference between unworked and worked penetration is more important in selecting soda base than calcium or aluminum base greases. The softer grades—No. 0 to No. 2 consistencies—in calcium or aluminum greases are not affected to a great extent by the action of a properly lubricated bearing. However, the heavier consistencies—Nos. 3, 4 and 5 and over—do show a large range between worked and unworked consistency and must be taken into consideration.

(3) Multi-purpose greases—water-resistant types—covering both low and high temperature applications.

In general, multi-purpose greases must possess the following general characteristics: (1) good work or shear stability; (2) usable over wide temperature range; (3) good water resistance; and (4) physical structure acceptable for all types of bearings and satisfactory for use in dispensing equipment.

The barium base grease in general use is of a short, fibrous nature in appearance. It is highly water resistant, has a dropping point ranging about 400 F and shows very little breakdown under working. These properties put it in the class of the multi-purpose lubricant as, generally, only one consistency product is required.

Barium greases are applicable to over wide temperature ranges and have proven to be exceptionally successful for high temperature lubrication. They have good tenacity for metal surfaces resulting in superior adhesion to surfaces and retention in bearings.

The good grades of lithium base greases, also possess the qualifications of a multi-purpose grease, namely mechanical stability, water resistance and stability over wide temperature ranges.

The dropping point of lithium grease is lower than that of barium grease—about 350 F. Because of its smooth, buttery nature and the physical properties of lithium soap, it is somewhat superior to barium grease for very low temperature applications. This same characteristic also makes handling and dispensing somewhat easier.

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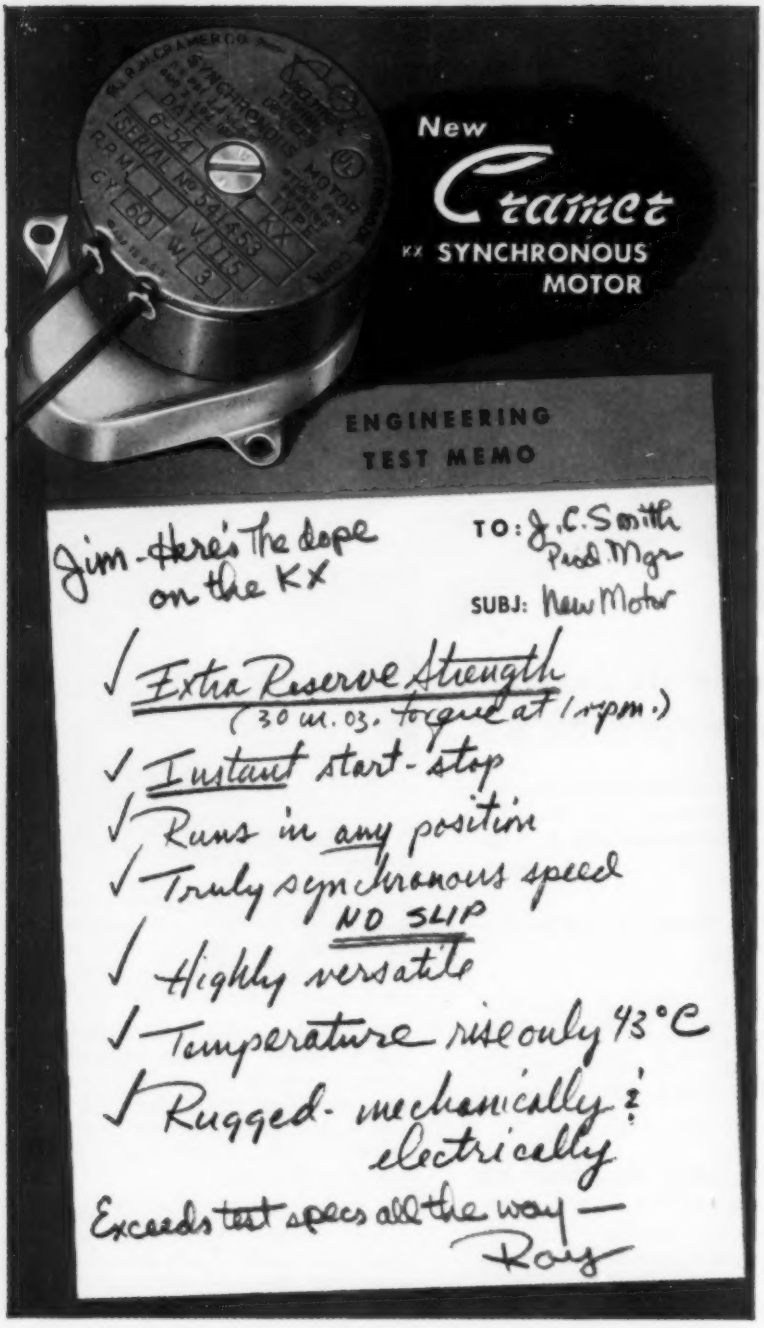

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eners for manufacturing lubricating greases are the so-called inorganic gell agents comprising specially purified and treated clays (Bentone and Permagel) and fine particle silica.

Lubricating greases produced from these materials have an outstanding characteristic—they have no melting or dropping point. Even when exposed to blow torch heat they do not melt or drip. These products, therefore, are very successful at extremely high temperatures. However, caution must be exercised, for since the grease does not melt, the flash point, evaporation point or coking point of the oil contained in the grease becomes the critical feature in these products. The tendency, if used at temperatures approaching the critical constants mentioned above the oil, is to become gummy or hard, eventually forming a coke unless proper regreasing and flushing intervals are established.

The low temperature characteristics of these gell type products are directly related to oil viscosity and pour point and to grease consistency. Since they do not contain soaps, which themselves become harder and more viscous at low temperatures, the gell type greases are somewhat superior to barium and lithium greases for extreme low temperature applications.

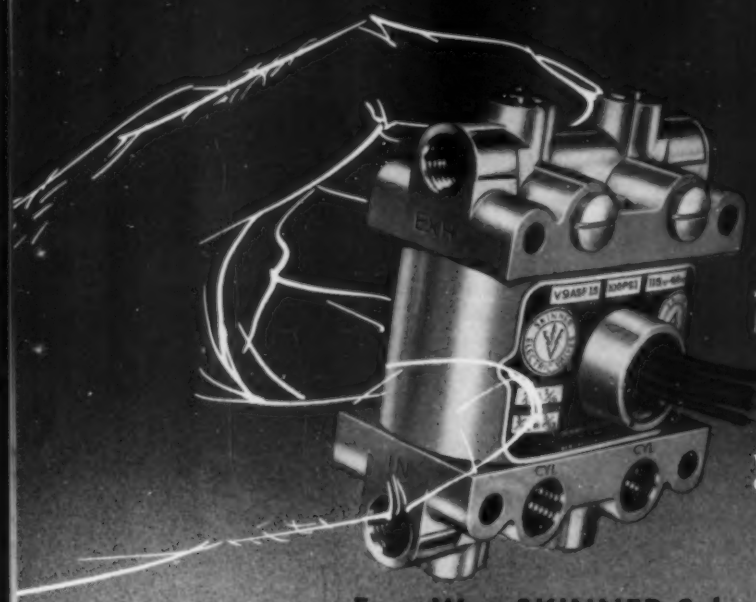
These lubricants are of smooth, buttery structure, putting them on a par with lithium greases from a handling and dispensing standpoint. Their mechanical stability is also very good.

The Bentone greases are very water tolerant being capable of absorbing considerable quantities of water without noticeable change in consistency. Permagel and silica products must be specially treated to prevent water attack, such treatment being reasonably successful. However, from a water resistance or tolerance standpoint, the latter two products are the poorest in the multi-purpose class.

(4) Greases using synthetic fluids in place of natural mineral oils.

These products are produced in most cases by the use of normal types of soaps or gell agents but substituting the synthetic types of hydrocarbons for normal mineral oils.

The greases have great possibilities in both low and high temperature operations and are produced in both water soluble and unsoluble types in many consistency ranges and viscosity ranges of the fluids.



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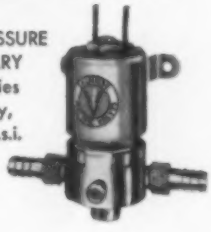

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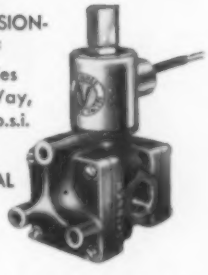

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Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

"Simplified Drafting Practice" Is a Stimulating Summary

To the Editor:

Some comments on the book "Simplified Drafting Practice" by Healy and Rau, have tended to be antagonistic. (See references at end of article.) That appears to have resulted from considering the book as a manual to be applied as a whole. I have pereferred to think about it as a series of suggestions, usable at specific times and places.

Everyone agrees that drawings should be easy to make and easy to read. However, it seems obvious that unfamiliar simplification, carried out suddenly, will cause drawings to be misinterpreted. At best, that will cause temporary local difficulties; at worst, if drawings are oversimplified, the intentions of designers may be hard to determine, and the drawings may be sources of recurring disagreements.

As the authors state in Chapter 1, simplified methods of specifying screw threads have been in use for many years. Other simplifications are already practiced nationally. Most factories have stopped making drawings of fasteners and other parts that can be described adequately by words or symbols. Instructions about piping, electrical circuits, welding, and designs of many other kinds are described on drawings in simplified form. These shortcuts cause no misunderstandings, because they are well known. Some of the methods described in "Simplified Drafting Practice" are not well known or widely followed on manufacturing drawings; for example, arrowless dimensioning (Chapter 7), and one-line drawings (page 76). It would seem reasonable not to adopt these methods until people who make the drawings, as well as people who take information or instructions from the drawings, have been thoroughly indoctrinated.

An accurate picture is likely to reduce misinterpretations, so its importance should not be underestimated. Clear dimensioning is essential; and most people seem to understand dimensions more easily if drawings are made accurately to scale. An accurate picture will always be clear everywhere; that may not be true if the pictures are made too simple. It would certainly be less difficult to make various people understand what is meant by the conventional drawings of Fig. 137, on page 66, than by the simplified versions.

Almost every drawing shows some evidence of compromise between complete pictorial representation and complete symbolization with no pictorial elements. Both the degree and kind of pictorial simplification vary with purposes of the drawings. For example, a drawing showing the piping of a building commonly refers to valves by standard symbols, not by accurate scale drawings of the pieces. However, you may be sure that the factory that makes the valves relies on well made scale drawings to inform all concerned exactly what size and shape each part must have. Simplified drawings such as Fig. 171, page 79, may be quite satisfactory where skilled workmen fabricate a small number of pieces for assembly into a special machine or into a building. For mass production of interchangeable parts, a drawing of that kind would probably not convey information reliably, regardless of educational effort; too many people are involved and too many kinds of information are needed.

Freehand drawing is widely used for some purposes. An engineer makes a freehand sketch to guide his draftsman, or for other reasons. Or a factory foreman makes a freehand sketch to list information not carried by engineering drawings. Other examples can be found, by the score. But freehand drawings are often not acceptable as instructions to production departments, where mistakes are costly out of all proportion to drafting time and expense. The economy of freehand drawing does not raise questions about whether drawings should be made that way; the question is, where can freehand drawings be used safely.

In "Simplified Drafting Practice," the one-line drawing, Fig. 165 on page 77, is based on outside dimensions. Fig. 127 on page 63 is center-line dimensioned. Is it intended that each

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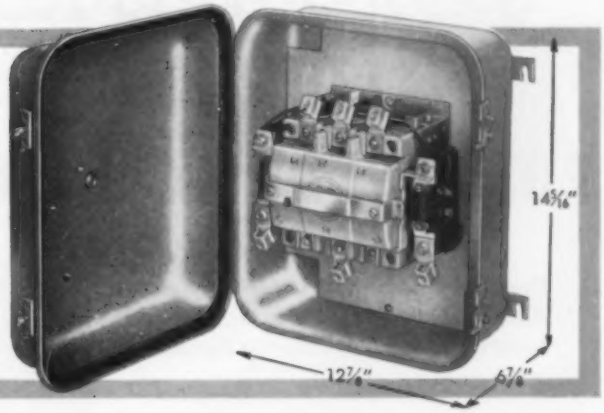

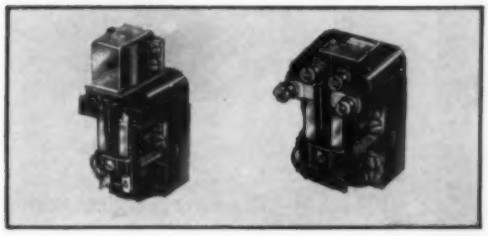

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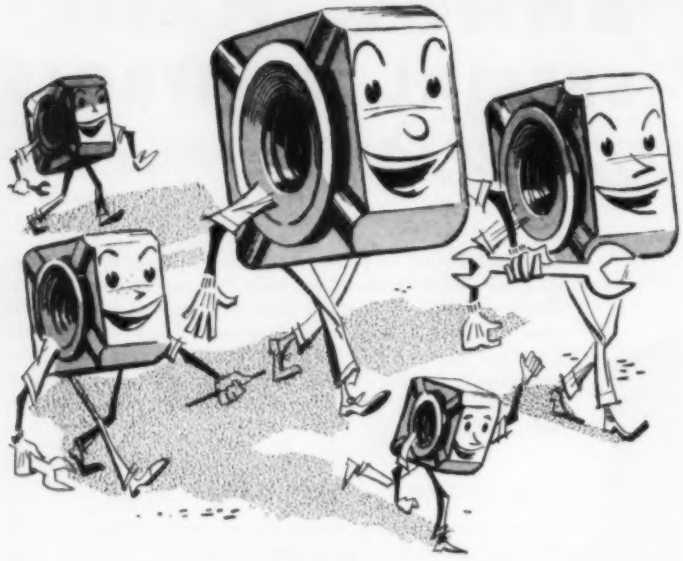

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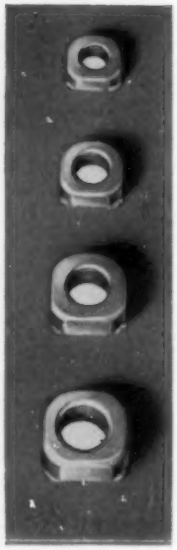

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one-line drawing shall state what the figures mean?

"Shop-Run" tolerances, not stated on drawings, are usually discouraged in mass-production industries, where it has been found advisable to state a tolerance on each dimension.

On page 94, under "Specific Tolerance on each Dimension," the statement is made, "When written in this form the maximum limit is always placed at the top." American Standard Z14.1-1946 recommends placing the limit figures that indicate maximum metal at the top; that is, the minimum diameter of a hole, or the maximum diameter of a shaft.

On page 21, a distinction is made between accuracy and precision. The relation of a precise (or accurate) picture to accurate (or precise) dimensioning is probably not made understandable to most people by any such arbitrary selection of meanings.

Many mechanical time-savers are listed in Chapters 5, 12 and 13; prepunched drawing forms with rounded corners, reproducing methods, etc. Probably every drafting room uses some of these methods, and these chapters are worth having for reference purposes.

Summary: Time-saving methods are valuable, but should be regulated by national standards. Unfamiliar methods should be used with caution, making sure they will not cause confusion. This book is of value as a stimulating summary, rather than as a drafting manual.

—CRAIG TELFER
Camera Works,
Eastman Kodak Company

References

"Simplified Drafting" by Healy and Rau, published by John Wiley & Sons, Inc. See extensive review in June 1953, page 334.

"Expensive Fancies," editorial by G. F. Nordenholt, December 1953, page 127.

"More on Expensive Fancies," by J. C. Shigley (and others), Feb. 1954, starting on page 282.

"And Still More Expensive Fancies," by G. E. Rowbotham (and others), April 1954, page 289.

"Simplified Drawing Aids," by John Kosar, May 1954, page 318.

"Should Current Drafting Practice Be Further Simplified," by J. Gerardi,

May 1954, page 161 (reprint available on letterhead request).

"Standardization in Drafting Practice," June 1954, page 320.

"Incomplete Drawings — Complete Confusion," by G. E. Rowbotham, July 1954, page 312.

"Another General Electric Engineer Boosts Simplified Drafting Method," by W. H. Buchanan, August 1954, page 320.

Block Letters on Drawings?

To the Editor:

As an interested reader of your editorials, I would like to pass on a suggestion for a topic which might be more useful to your readers than to those of *Canadian Machinery*.

IS BLOCK LETTERING
BEST FOR OUR DRAWINGS?

Perhaps the major advantage of block lettering is that it can be used in kidnap notes to give graphologists a bad moment trying to identify the writer. Or, in a completely different vein, people who insist on capital letters on drawings would receive a rude awakening (and I do assume they are asleep at the time they receive their morning paper) if their favorite daily paper were handed to them printed entirely in capitals.

No doubt you have some thoughts of your own on the subject, particularly as a result of principles developed in connection with page layout. Two of the factors involved are appearance and training. I am told reading studies have shown that lower case words starting with capitals are more easily read than all-capital text.

In connection with our engineering course, we were taught to use lower case lettering on drawings and I imagine the majority of drafting instructors teach the same system. Unfortunately, my early training has stayed with me and I have been unable to make block letters as neatly as the others, although a number of employers have insisted on the use of block letters. —M. Conklin,
Assistant Editor Canadian Machinery
Toronto, Canada

Ed—Comments on the pros and cons concerning the use of block letters on engineering drawings would be welcomed by the editor.

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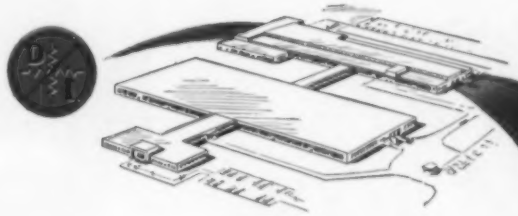

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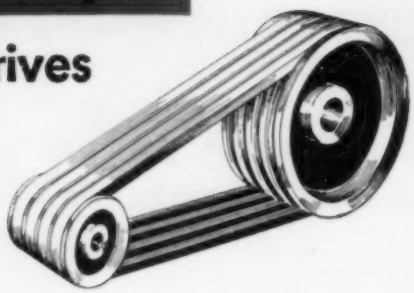

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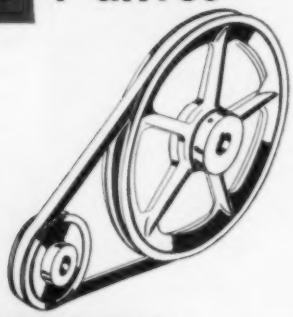

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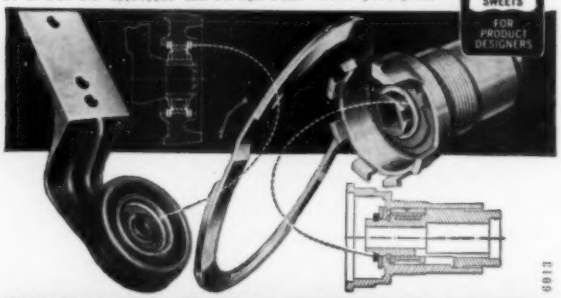

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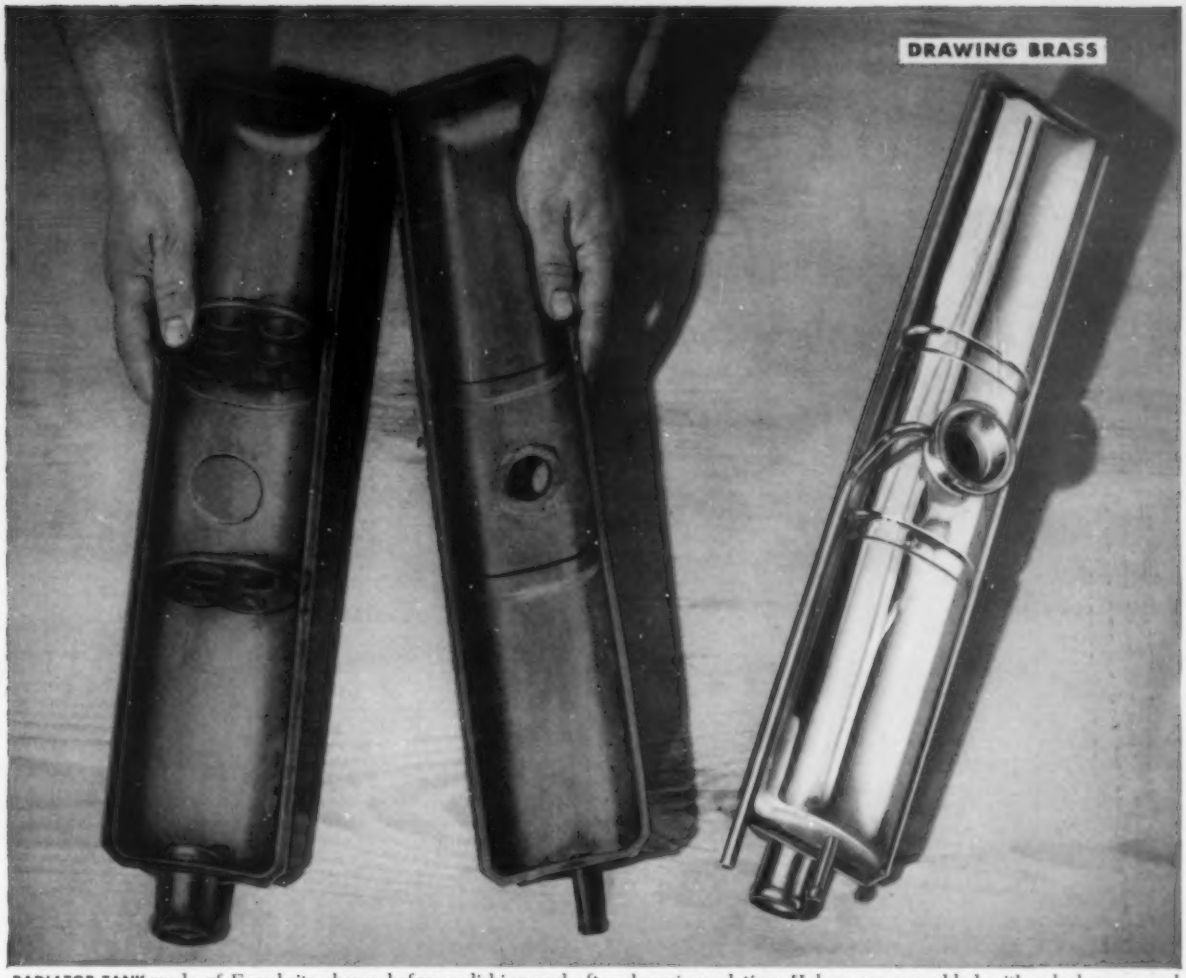

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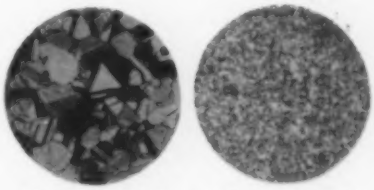

75x magnification of ordinary drawing brass. 75x magnification of superfine-grain Formbrite.

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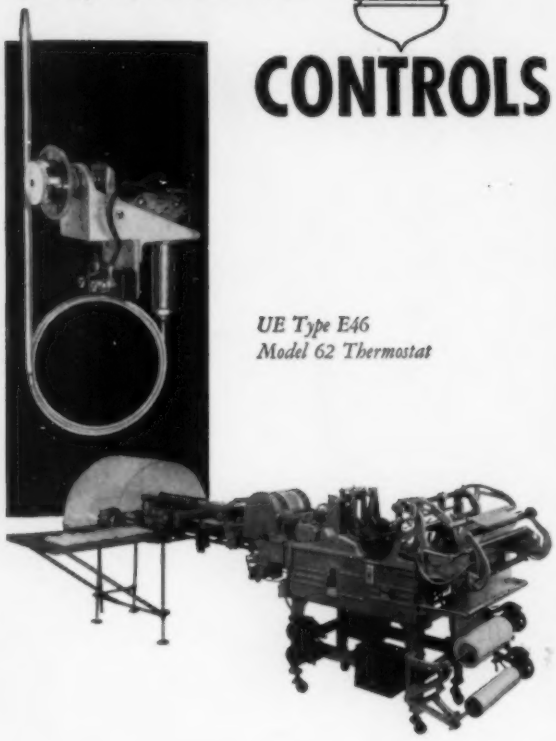

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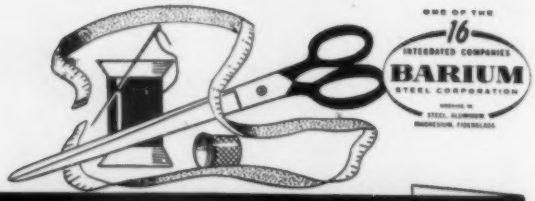

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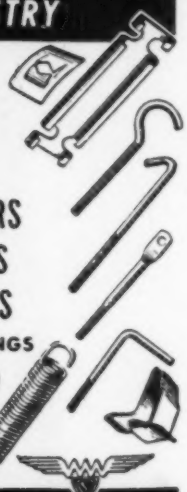

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5/16"	.050-.055
11/32"	.050-.055

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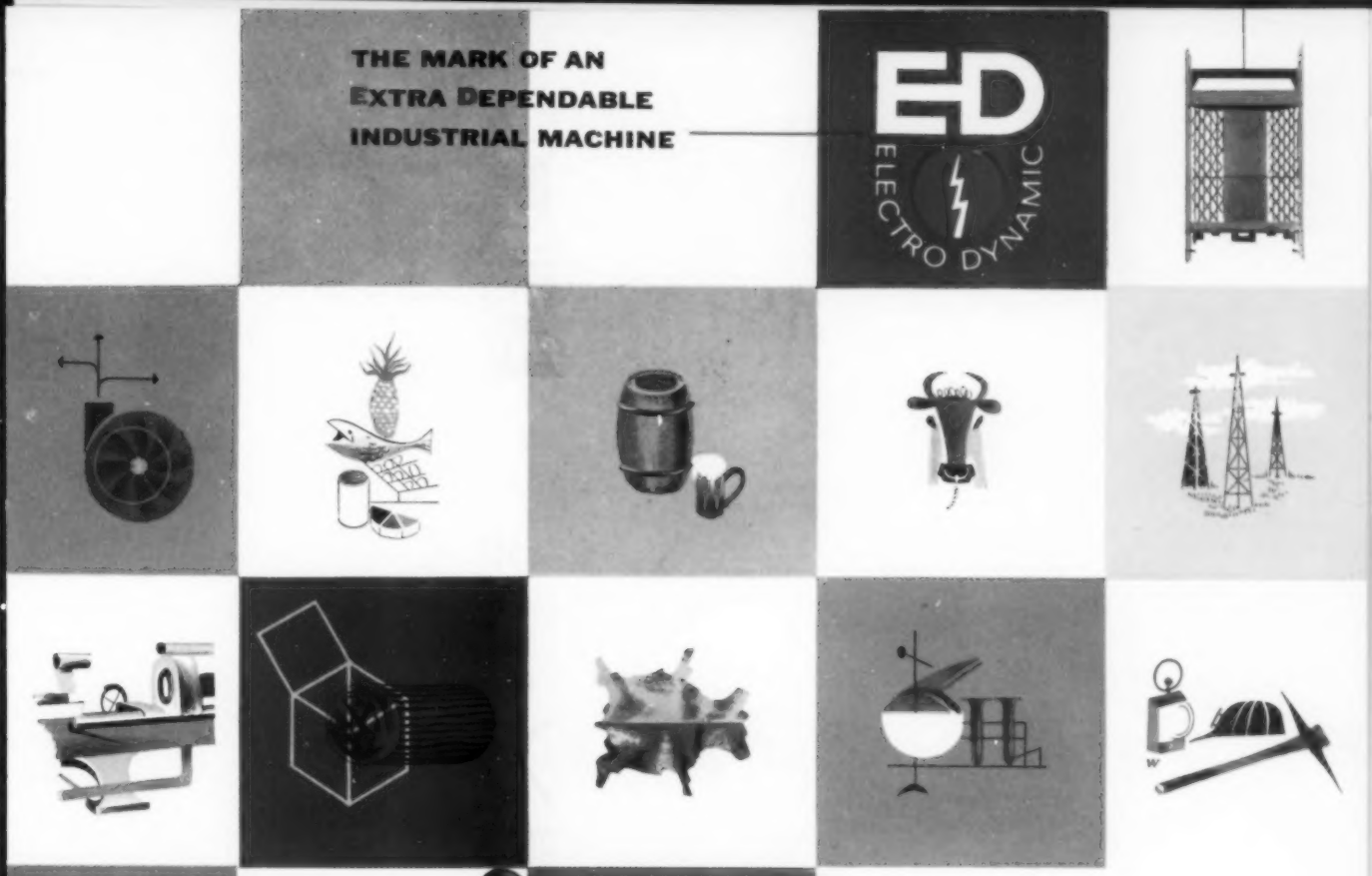

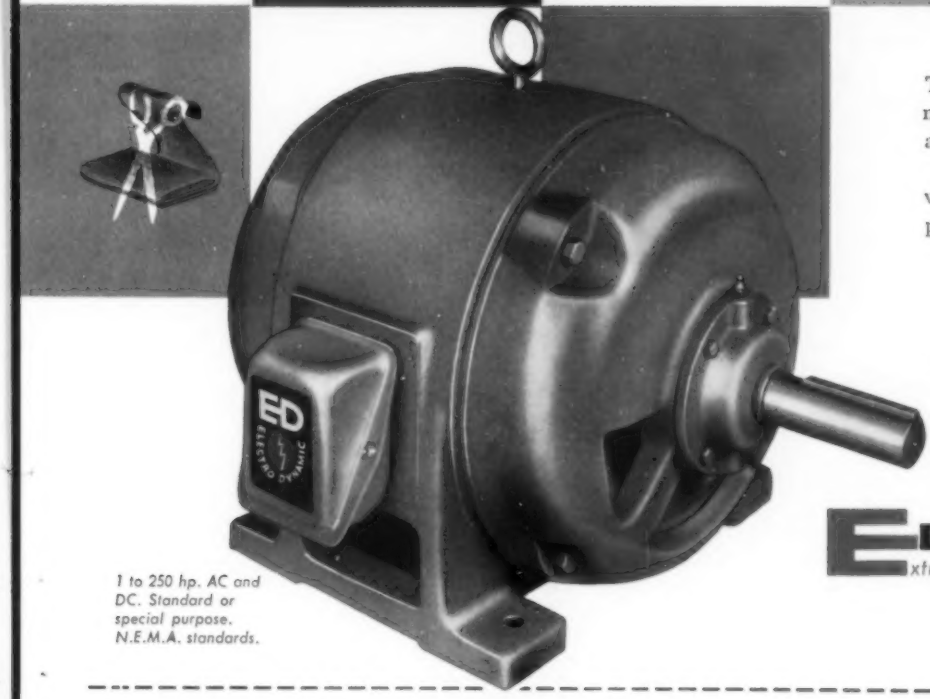

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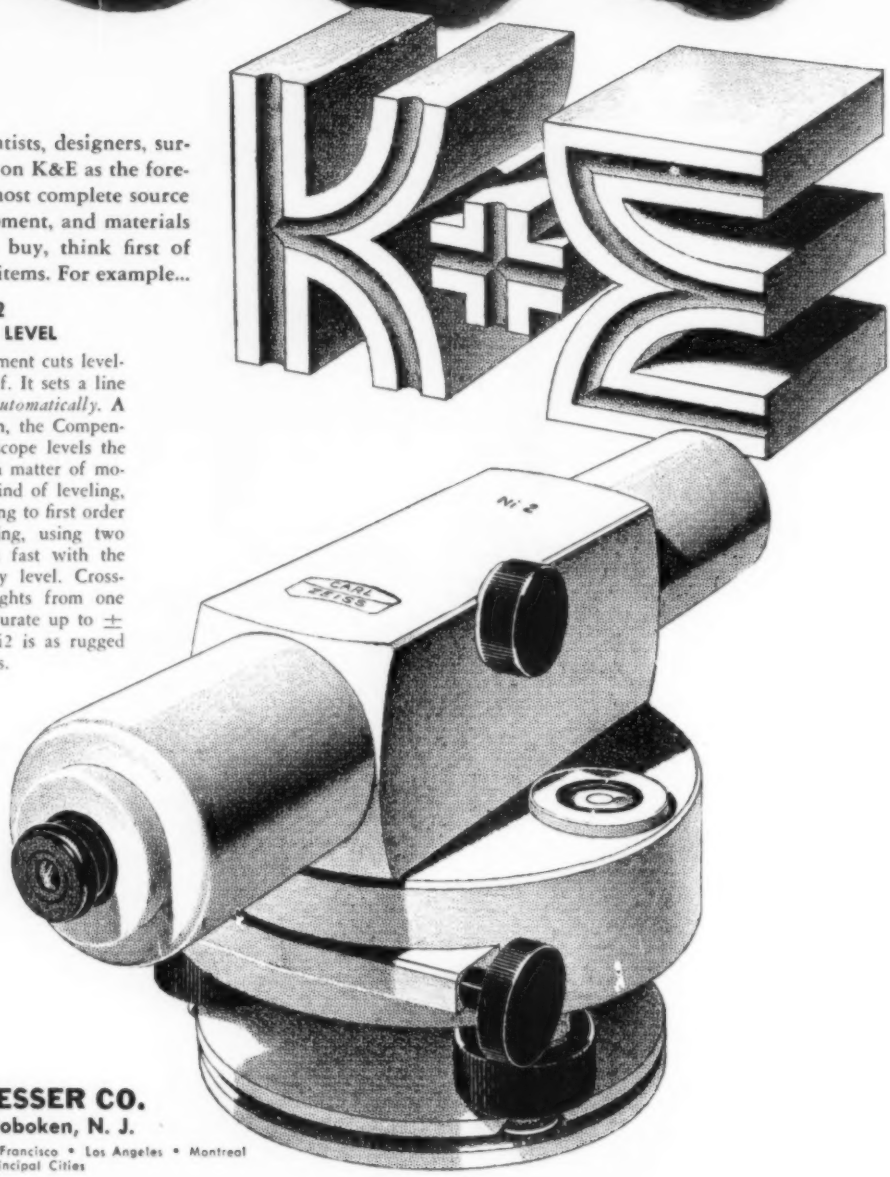

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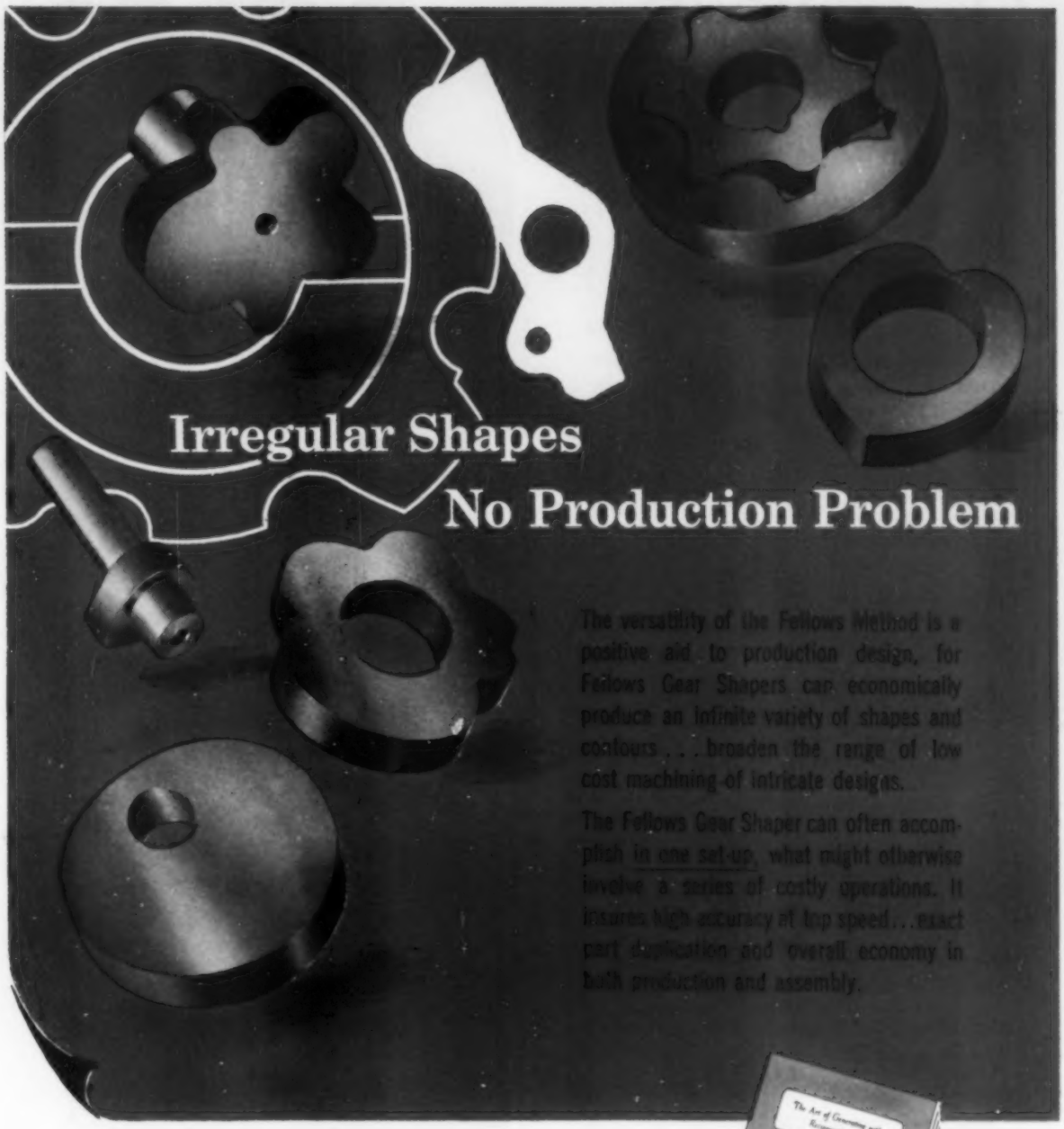

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A blazing tropical sun, coupled with the destructive forces of penetrating dust and moisture, can quickly shorten the life of any electric motor . . . unless it is totally *weatherproofed* to stand up under the severest conditions, outdoors or indoors. Such weatherproofing is a *standard operation* in the manufacture of every Brook motor . . . for fifty years, the world's most respected motor!

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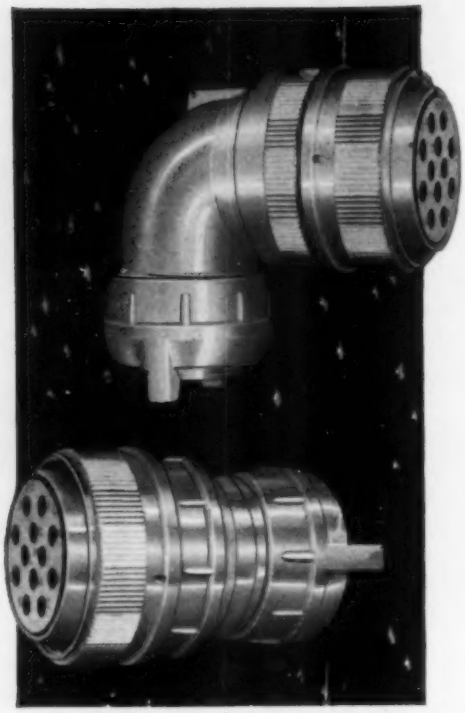

BENDIX·SCINFLEX WATERPROOF PLUGS

for use with multi-conductor cables

These new Bendix*-Scinflex *waterproof* plugs are a modification of our standard AN type "E" (environment resistant) connector. They are designed to meet all "E" performance requirements when used with multi-conductor cables. Each plug includes a modified AN3057B cable clamp which provides inward radial compression on multi-conductor cables. This unique feature completely eliminates cable strain—a common source of circuit trouble.

In addition, there are gaskets at all mating surfaces and an accessory sleeve is available to accommodate an extreme range of cable sizes. A folder describing this new waterproof plug—and the various sizes in which it is manufactured—may be obtained by writing our Sales Department.

*TRADE-MARK

THESE BUILT-IN FEATURES ASSURE TOP PROTECTION AGAINST CIRCUIT FAILURE:

Shock and Vibration Resistant • Die Cast Aluminum Shell • Cadmium Plate—Olive Drab Finish • Moisture-Proof, Pressurized • High Arc Resistance, High Dielectric Strength Silver-Plated Contacts • Resilient Inserts

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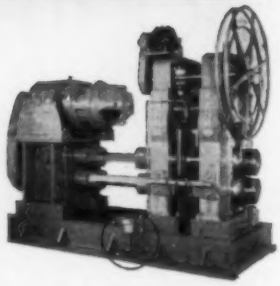
THERE'S NO SUBSTITUTE FOR KNOW HOW

Your RUTHMAN GUSHER COOLANT PUMPS give you



Illustrated is a Fenn No. 121 Two High Roller Bearing Rolling Mill equipped with a Model 5-P3 Long Gusher Coolant Pump.

1 ***Experience in Design*** . . . Ruthman Gusher Coolant Pumps were first in their field and have maintained their leadership over the years. Ruthman engineers are constantly at work to bring you an even better Gusher Pump.

2 ***Precision Built.*** Only tested materials and the best workmanship go into your Gusher Coolant Pumps. You can be sure of a long trouble-free life.

3 ***Efficient Operation*** is inherent in Gusher Pumps. You get split-second coolant flow and they require no priming or packing.

Always Specify Ruthman Gusher Coolant Pumps.

THE RUTHMAN MACHINERY CO.

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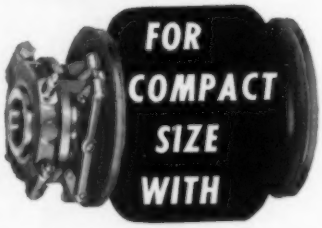
DESIGN FOR COMPACT SIZE WITH



Engineered to deliver maximum torque — with minimum size — ROCKFORD CLUTCHES provide abundant brawn, without unnecessary bulk. Spring-loaded and over-center, single or double-plate, or multiple-disc types fit compactly into product designs. If your project calls for a drive that *must* fit neatly into limited space, consult ROCKFORD clutch engineers — while your size problem still is on the drawing board.

Send for This Handy Bulletin

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION
BORG-WARNER
209 Catherine Street, Rockford, Illinois

ROCKFORD CLUTCHES

CORNING GLASS BULLETIN

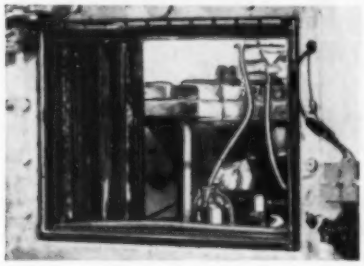
FOR PRODUCT DESIGNERS

Gamma guardians for protection and perception. Gamma rays are one of the dangers you encounter in taming atomic energy. Those who delve into molecular manifestations often face the double problem of how to *see* what they're doing while keeping out of reach of lethal radiations. Happily, glass can extricate you from both horns of this dilemma.

Our Harrodsburg plant recently cast and assembled what're undoubtedly the heaviest glass windows in the world, designed for the protection of employees working on an atomic power development program. Some of these windows are 5½ x 8 feet in area and weigh 12 tons.

Glasses for such windows come in three different densities—one has a density of 3.3, which has very high light transmission and doesn't brown when gamma rays hit it; the second a density of 6.2—about the densest glass ever made; almost as dense as steel and six times heavier than water. And the third has a density of 2.7 to match that of concrete.

By using those remarkable remote-control manipulators you've seen pictures of, scientists are able to perform their experiments by looking through these windows without fear of radiation injury.



▶ Maybe you're not in the market for a 12-ton, gamma-absorbent window, but if you have any kind of problem calling for the selective absorption and/or transmission of *rays* —cosmic, atomic, X-, ultraviolet, visible, infrared, micro-, radio, what have you, we might be able to help you find a solution. Leastwise, we'd be delighted to hear from you as a starter.

Laboratory ⇄ ?

Some years ago an enterprising designer came into possession of a simple piece of PYREX brand laboratory ware—a standard flask. With a certain ingenuity and imagination, and the aid of some material to wind around the neck, he transformed this laboratory flask into a beautiful (and salable) coffee carafe.

Since that time, other equally sales-minded designers have designed everything from flower vases to sugar bowls from laboratory glassware. The sales appeal of such items is built in with clean simple lines, heat resistance, functional design and the glistening attractiveness of glass.

Thus, such as humble laboratory flasks travel the oft-unyielding distance from lab to home on the wings of men's creative imagination.

The reverse happened to a bowl we make for manufacturers of kitchen blenders. This time the creative wings carried our product from home kitchen to laboratory. It came about when some fellows in a laboratory hit upon the idea of adapting these kitchen blender bowls to laboratory blending purposes. Simple, huh?

▶ The starting point for other potentially rewarding ventures could well lie hidden among the more than 40,000 standard items on the Corning product shelves. Could be you're next in line to put the magic of imagination to work projecting one of these into a new area of utility. The first step on this "maybe road" to fame and fortune is simple: Just drop us a note requesting same and we'll let loose a deluge of data on standard items.

How to engineer a platypus. A happy combination of purposeful practicality is the furry platypus with its webbed feet, beaver's tail, and duck's bill.

A lot of our customers, to their continuing delight and profit (we hope), have discovered that glass is sort of platypus-like in that it, too, can be made to combine many useful characteristics.

Take, for example, PYREX brand pipe. Here you see a man using a piece of it to drive one-inch nails in a pine plank. This is essentially an extra-curricular activity for glass pipe, which is more at home conveying metal-eating acids around chemical plants, but it's a way of showing just how tough glass can be when it's *made* that way.

All of which may serve to illustrate for you how we can arrange the optical, chemical, thermal, mechanical, and electrical properties of glass in different combinations to match a considerable variety of end-use requirements. In fact, we've worked up some 50,000 different formulas for glass in our years of helping customers solve specific design and processing problems.

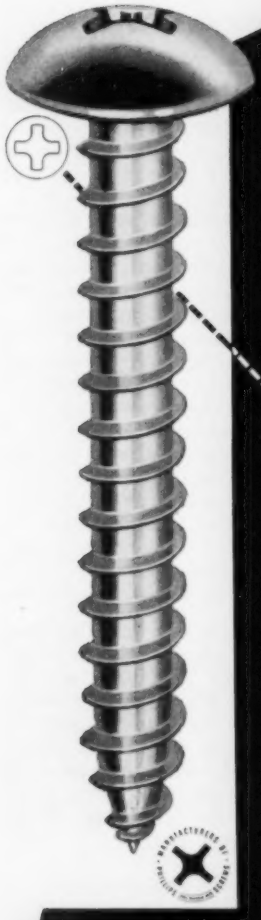
▶ If platypus-like glass is a novel idea to you, if you've never given glass a second thought as a highly adaptable design and construction material, we suggest your reading a pocket-size volume entitled "Glass and You." It tells in a few words and many pictures how glass contributes to profit and pleasure and we'd be delighted to send you a copy. Or, if you're more concerned with putting glass to work for you than in learning what it's doing for others, there's a slightly more technical bulletin called, "Glass—its increasing importance in product design." We'll be glad to send you either—or both.

In all fairness to you—and to glass, too, we must admit that this is not the whole story. Fact is, experience indicates that it's *customer* ideas and problems that really bring out the best in glass. So, even if what's on your mind seems unrelated to any item this page discusses, glass may still be its fulfillment. We'd like to hear from you.

Corning means research in Glass

CORNING GLASS WORKS 10-10 Crystal St., Corning, N.Y.

ELCO PHILLIPS CROSS-RECESSED SCREWS



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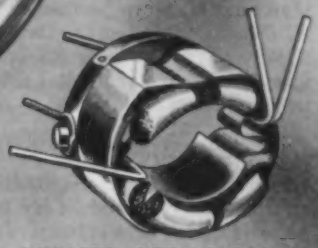
LOW IN EXTRACTABLES —best for use with FREON 12



RESISTS ABRASION —takes pounding pressure winding abuse

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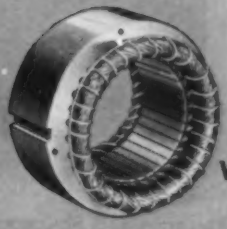

WINDABILITY —smaller coils

FORMVAR MAGNET WIRE by Belden

WIREMAKER FOR INDUSTRY

Durability against vibration assured by SPERRY designers

. . . with a shake-testing program on

MB VIBRATION EXCITERS

In a Vibration Test Section of Sperry Gyroscope Company, an MB Vibration Exciter Model C-5 is being used to fulfill requirements of MIL-E-5272 and other specification tests.

COMPANIES quick to take advantage of newest techniques for development and testing are generally also those known for outstanding products. Such a concern is the Sperry Gyroscope Company. It maintains well-equipped vibration testing laboratories where searching tests are performed on all designs subjected to vibration in service. Vibration is ruled out as a trouble-maker in vital products and components.

VIBRATION TESTING SPEEDS DATA

With vibration now recognized as an archenemy of product life and performance, it pays to learn early in the game whether corrections in design are needed. MB Shakers can help *you* to do just that. In a few short hours, the equipment can reproduce the ravages of *years* of vibratory service conditions. Within minutes, it can show you visually the vibratory response of a product to a whole range of frequencies.

The result: *savings in engineering time and work, and a better product.*

WHY MB VIBRATION EXCITERS?

Engineered by vibration specialists to deliver maximum performance, MB Shakers can be counted on for pure table motion and dependable operation to full rated capacity. Moreover, MB's line of vibration testing "tools" is complete—from small specialized-duty shakers to the largest in existence today; also automatic cycling systems, vibration pickups, meters and other accessories.

Like so many well known companies, why not make MB *your* headquarters on vibration?

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

BULLETIN TELLS MORE
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-6.

HEADQUARTERS FOR PRODUCTS TO *ISOLATE* VIBRATION...TO *EXCITE* IT...TO *MEASURE* IT

...solid foundation
FOR TODAY'S COMPACT MOTOR DESIGN
There are, as you know, new NEMA Standards for electric motors ... more power in less space
When you look for a new NEMA frame motor, look for the one that is built on a solid foundation ... it carries the Fairbanks-Morse Seal of Quality.
The Standards are new .. But the Idea Is Not
Like the recent Fairbanks-Morse developments in other lines, the new F-M motor is the result of a basic engineering philosophy: More Performance in Less Space—a 120-year tradition at Fairbanks-Morse. Fairbanks, Morse & Co., 600 South Michigan Avenue, Chicago 5, Illinois
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a name worth remembering when you want the best
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NEW LOCOMOTIVE DESIGN
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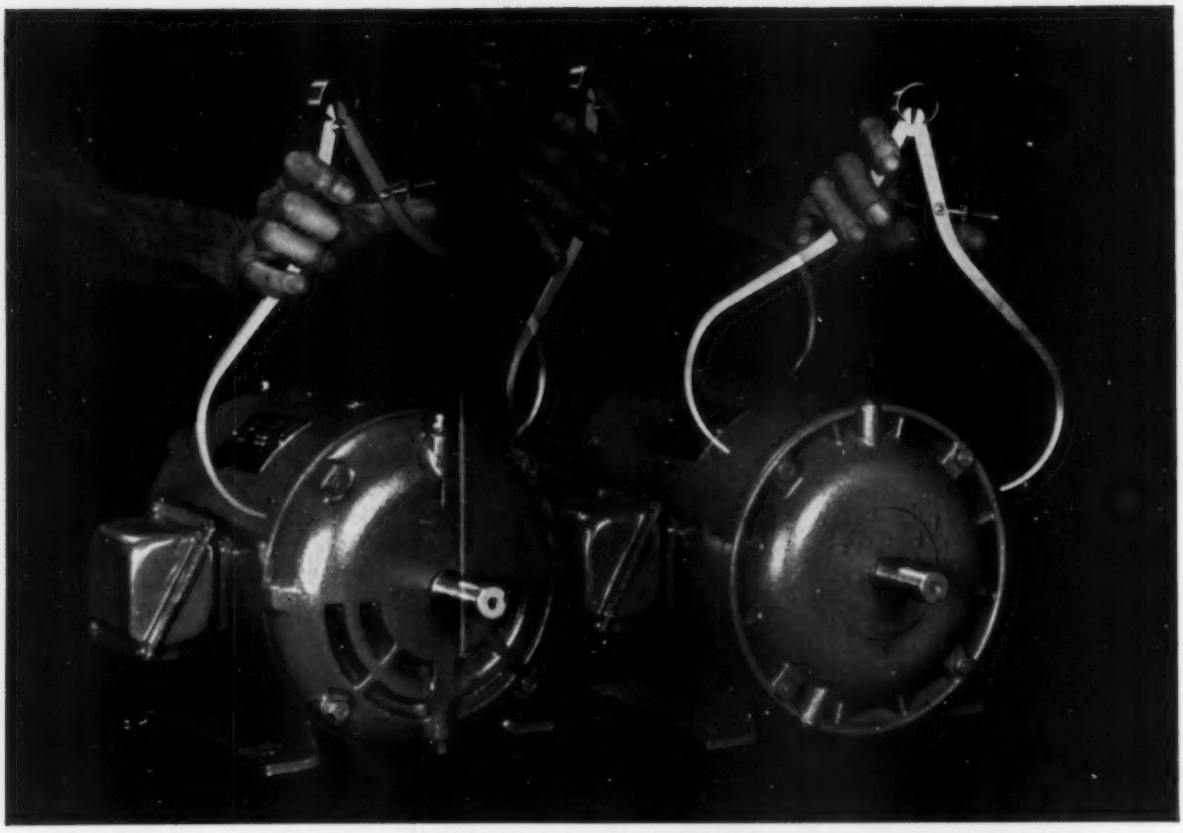
NEW MAGNETO DESIGN
NEW PUMP DESIGN



Series 100 Open Motors are lighter in weight and take up to 30% less space than open motors of old NEMA frame sizes.

Series 100 TEFC Motors have same diameters as the Series 100 Open Motors, for easier interchangeability.

New Howell Series 100 open and TEFC motors have same diameters!

Howell's new re-rated motors save space, are easier to interchange! Feature double-shielded bearings . . . serve your needs better *all* ways.

If space ever limited your use of motors, here's welcome news: Series 100 Open and TEFC Motors have the same diameters! The reason? – Howell's exclusive ventilating system. This system cools *internally* providing 50% more contact between cooling air and active lamination materials. Result: you get motors that meet minimum space requirements . . . that run cooler than established ratings . . . that have increased load capacities – you get improved performance and longer life!

Less maintenance, too! New double-shielded bearings are standard on both the open and TEFC motors. These bearings seal grease in – dirt out. And where operating conditions are severe, you can re-grease them quickly, easily. Actual use proves these double-shielded bearings best for most applications; however, any type can be furnished.

Meet your special needs! New Series 100 Motors provide dependable copper rotors – three diameters for each frame size to assure design flexibility. Special corrosion-resistant materials and fittings are available.

Before you buy any re-rated motor, compare Howell's Series 100 Motors – for modern design, outstanding performance and precision engineering. Howell will continue to make a complete line of regular and special motors–with over 20,000 electrical design specifications to serve you. Call your Howell man today or write for Bulletin N-100!

HOWELL Red Band MOTORS

HOWELL MOTORS

Howell Electric Motors Company, Howell, Michigan

MOTORS FOR INDUSTRY SINCE 1915

Production savings with...

HUNTER DOUGLAS

VALVE SHOWN ACTUAL SIZE

COLD FORGING

FROM

HIGH STRENGTH ALUMINUM ALLOYS

The stress valve component pictured above was cold forged in seconds by Hunter Douglas to produce a solid blank ready for the secondary machining operations of slotting and tapping.

The valve was cold forged from a slug containing one-tenth the metal that would be required if the same part were machined from bar stock! Conserving metal for the strategic stockpile, eliminating costly machining operations, yet producing a stronger part faster, are only some of the advantages realized by this process.

Hunter Douglas Cold Forging gives a dense, nonporous grain structure that follows the contour of the part. The metal is uniformly distributed to bosses, lugs, recesses and other symmetrical projections without sacrificing strength and with minimum metal waste. Dimensional tolerances are held to extremely close limits, with draft-free surfaces for easier chucking and surface smoothness in the range of 32 to 125 micro-inches.

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DIE-CAST ROUND-HEAD THUMB NUTS & SCREWS with GRC's exclusive WIDE GRIP feature

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3 standard head diameters; all standard thread sizes; open-end and closed-end thumb nuts; thumb screws with and without shoulders. Write *today* for samples, prices and bulletins . . . or ask for quote on special needs.

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As in all other GRC quality fasteners — wing nuts, cap nuts, wing screws—threads are clean and accurate.

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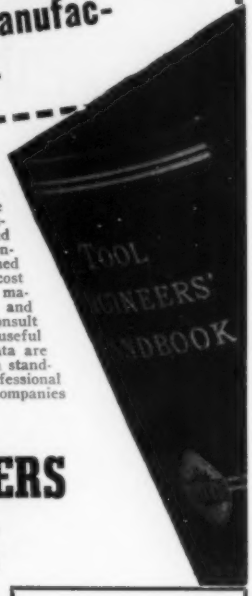
159 Beechwood Ave., New Rochelle, N. Y., 'Phone: New Rochelle 3-8600

An outstanding reference on all phases of planning, control, design, tooling and operations in the mechanical manufacturing industries.



THIS Handbook brings you the most modern, authoritative data on the design, fabrication, maintenance and economical use of tools and machinery used in industry. Of importance to anyone connected with mechanical processing of finished products, it covers product design and cost estimating, the economical selection of machines, processes and tools, the analysis and improvement of set-ups and operations. Consult it for rules, formulas, procedures and useful data. Use it with complete confidence; data are based, wherever possible and practicable, on standards established by the government, the professional associations, and leading industrial companies throughout the country.

TOOL ENGINEERS HANDBOOK

American Society of Tool Engineers

Frank W. Wilson, Editor-in-Chief

Written by 144 authorities in the field, this massive reference has been checked and double-checked to insure accuracy from cover to cover. Here are the complete authoritative answers to problems you meet from day to day—brought to you in compact, easy-to-find form.

More than 2000 pages! Over 1500 illustrations! Hundreds of tables, charts, keyed diagrams, symbols, definitions, equations, etc.

A small selection of highlights selected at random to illustrate the scope of this Handbook:

—Describes types of machines, cutting tools, toolholders, fixtures and operations in precision production boring.
—Includes all new techniques and processes of recognized acceptance including Powder Metallurgy, Investment Casting, Plastic Joining of Materials, etc.
—Conventional tables of feeds, speeds and cuts modernized to bring them into line with latest cutting-tool materials and cutting practices.
—Treats, process-wise, such topics as Plaster Mold Casting, Superfinishing, Rotary Swaging, Sheet and strip cold roll forming, Die Hobbing, etc.
—Covers every phase of metal cutting and machinability.
—Discusses welding, gluing and mechanical joining of materials.

Partial Listing of the Handbook's 115 Big Sections which Cover Tool Engineering from A to Z:

- Job Planning and Control
- Small Tools Planning and Control
- General Structure and Properties of Metals
- Properties and Workability of Plastics
- Plastics Forming
- Inspection Equipment and Methods
- Investment Casting
- Milling
- Shrinkage Fits
- Broaching
- Engine Lathes
- Power Bandsawing
- Gear Shaping
- Jigs and Fixtures
- Thread Chasing
- Pressworking of Metal
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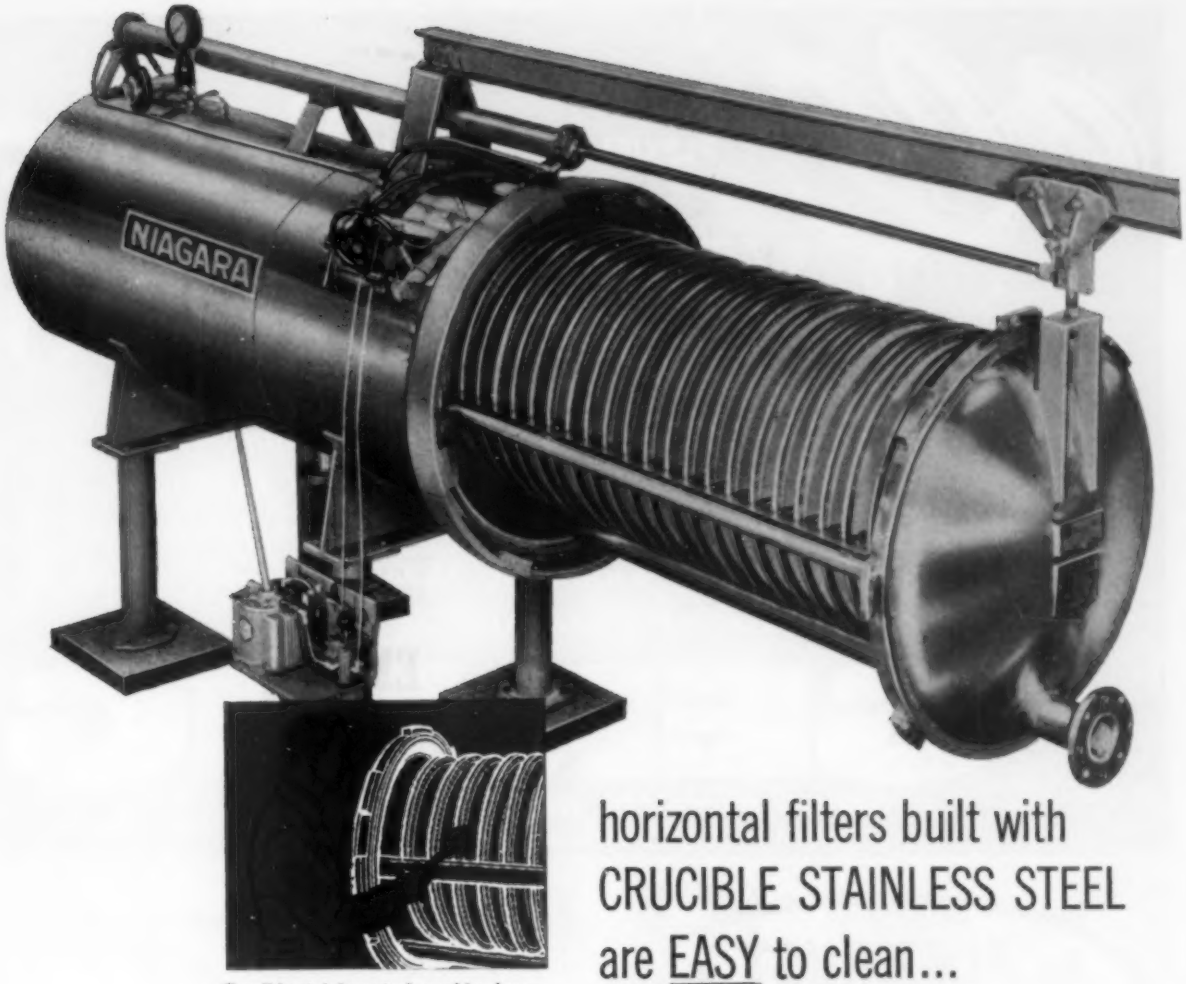

Crucible stainless steel, used by American Machine & Metals, Inc., in the fabrication of Niagara Horizontal pressure leaf Filters, assures ease of cleaning, long service life.

horizontal filters built with CRUCIBLE STAINLESS STEEL are EASY to clean... HARD to wear out

When solids have to be separated from liquids . . . when semidry cakes must be dislodged quickly and easily . . . and where minimum down time is vital—there's no unit like a horizontal pressure leaf filter. And when its materials must be strong enough to take rugged, continuous use without undue wear—there's no material like Crucible Rezistal® stainless steel.

In operation, horizontal filters like the one shown here, are cleaned by rolling out the leaves, and tapping with a rubber hammer. Crucible stainless leaves require no cloths—and seldom *or never* need to be replaced.

The story's the same with any process equipment. When you're choosing equipment that must stand up under heavy production schedules—take advantage of the proved reliability of Crucible stainless steel. Remember, too—Crucible . . . the world's leading producer of special purpose steels . . . is always ready to help you plan for new and different applications of stainless. So, for help of any kind—*call Crucible.*

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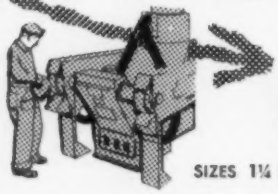

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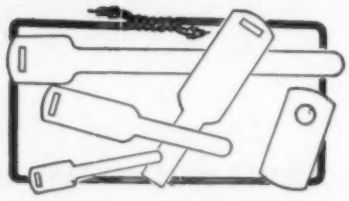

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You'll see how the elimination of flanges and undercuts on the inner ring provides a *wider* contact area for the rollers.

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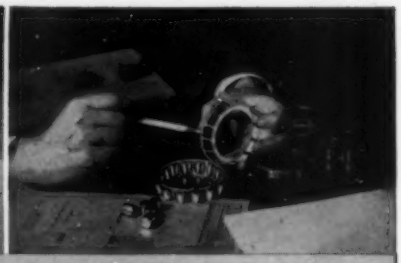
When SKF first announced that its *improved* (Type "C") Spherical Roller Bearing provides, size for size, up to 50% more capacity and 2 to 3½ times longer life than any other available design, most people asked:

"How was this done?"

Your SKF District Office has the answer, in the form of a clear, quick *visual* demonstration. Ask to see it—here, in outline, is what you'll see!

You'll see how much longer the Type "C" Rollers are than those in the original SKF design.

You'll see the way the rollers are *guided* by a separate floating guide ring, free to move axially.



You'll see the improved brass *window-type* cage—see why it's stronger and more effective.

You can see an exact comparison of original vs. Type "C" capacity and life in the sizes of sphericals you use.

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YES—We'd like to have an SKF Representative SHOW us WHY the improved SKF Type "C" Spherical provides, size for size, more capacity and longer life than any available spherical design.

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Skillful Molding

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Economical production has a special meaning for us that always results in better plastic products for you. Low priced—high volume items like this Burgess pocket flashlight illustrate how we put economy and quality to work together. Naturally costs had to be kept down while keeping quality "up" in producing this flashlight housing. Although it is a small and outwardly simple case, actually there was a definite and unique problem solved by making full use of a surprisingly compact space. Through careful engineering and advance planning we have developed our own method of cutting costs without ever cutting quality. This production skill that saves you money while giving you a better job is the core of our service to you. Let us show you how we can combine economical production and quality craftsmanship for your product. Tell us today when you want to see us.

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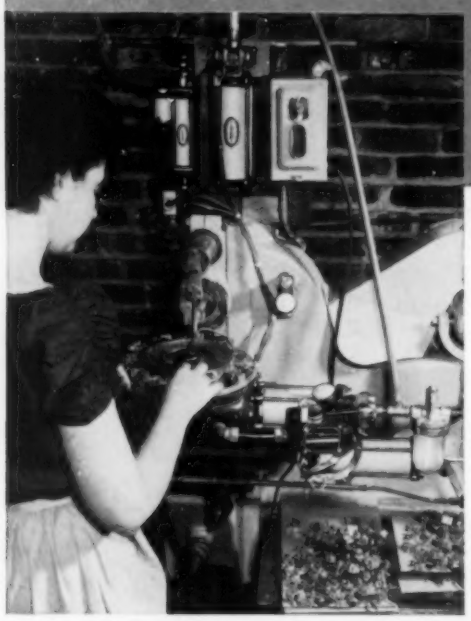
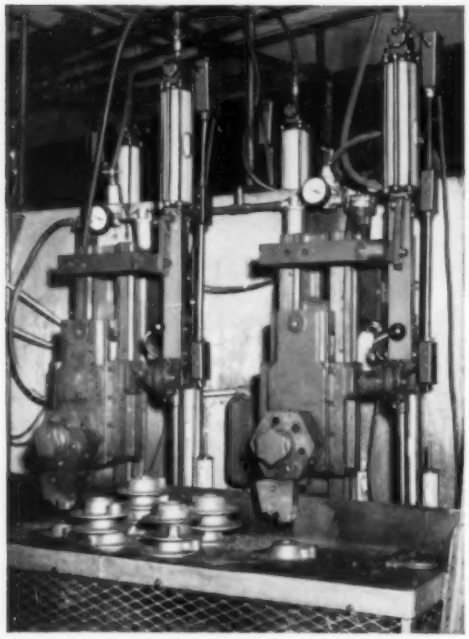
WITH THIS UNIQUE AIR MOTOR

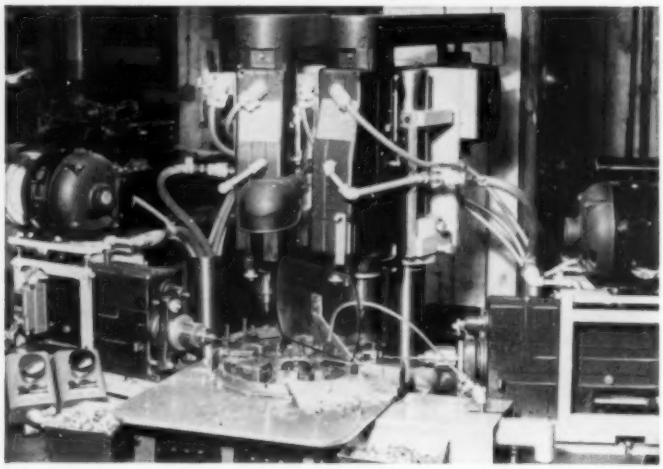


This semi-automatic set-up at Eastman Manufacturing Co. doubled production and eliminated fatigue in milling bakelite magneto parts.



A simple installation cut lathe time on steel ordnance parts from 90 to 10 seconds per piece at Joseph Pickard's Sons of Philadelphia.

you can build cost-cutting special machines or modernize existing machines right in your own shop with your own personnel

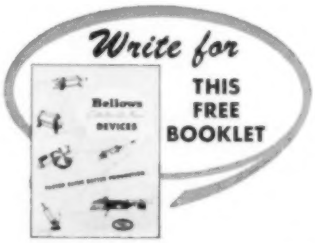


This drilling machine, built by Horrocks-Ibbotson, turned out 1 year's production of their fishing reel pawl blocks in 3 months.

Even for short runs you'll find special machines built around this versatile power unit will pay off in a big way — in greatly lowered costs, in fewer rejects, in better product quality. No expensive engineering is needed. In fact, your local Bellows Field Engineer may have in his Foto-Facts File basic designs that can be readily adapted to your product and your production processes.

Your own tool room can build such special machines at decidedly low cost, and quickly. Often they pay for themselves with the first week's savings.

Bulletin CL-50 tells the story of the Bellows Air Motor and the part it is playing in cutting manufacturing costs in hundreds of plants. Address. The Bellows Co., Dept. PE-1054, Akron 9, Ohio.



The Bellows Co.

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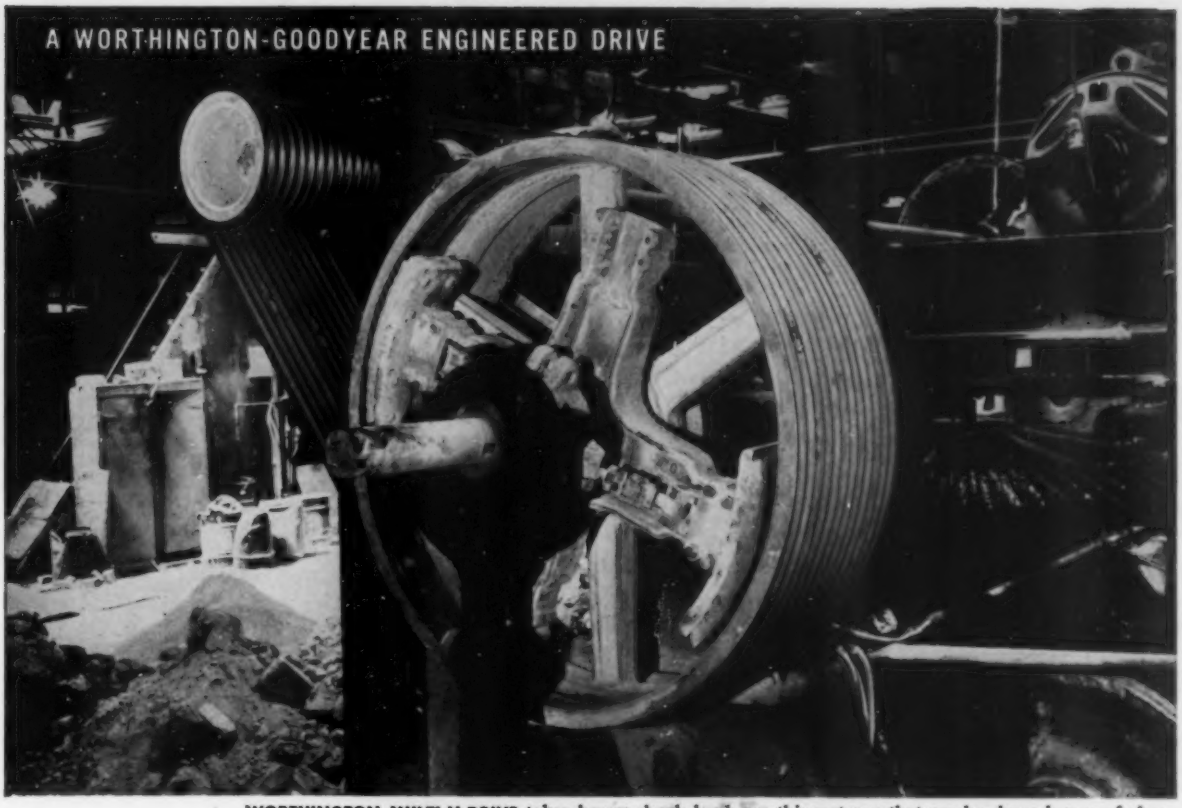
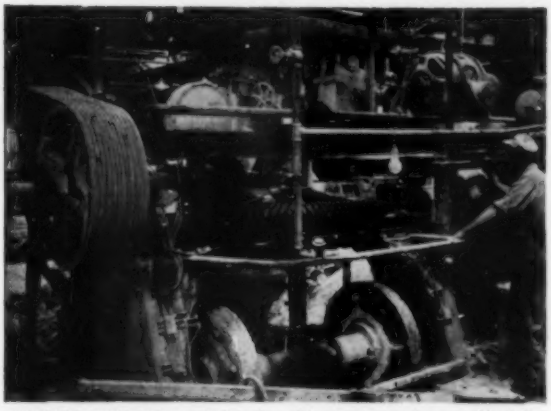


WORTHINGTON MULTI-V-DRIVE takes heavy shock loads on this wet-pan that crushes huge lumps of clay.

Belts hold as machine crushes 120-lb lumps



SMOOTH, NON-SLIP DRIVE for this wet-pan is provided by Worthington QD sheaves and Goodyear V-belts.

Worthington Multi-V-Drive solves critical drive problem

Driving a machine that crushes, mixes and tempers crude clay is a real workout for any mechanical power transmission setup—especially with lumps weighing as much as 120 pounds.

After two years of this heavy-duty operation, not one belt has been replaced on this wet-pan. And there's no noise, slippage of belts on sheaves, and no resulting power loss. Because of this fine record, Worthington Multi-V-Drives, with QD* sheaves and Worthington-Goodyear V-belts, will be installed on other wet-pan pulverizers.

Find out how this Worthington-Goodyear drive team can pay off for you, too. Write us. Worthington Corporation, Section MV.4.5, Oil City, Pa. *Reg.U.S.Pat.Off.

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SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON *YOUR* EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives

...EXAMINE THIS HOSE COUPLER...
will it help YOU?

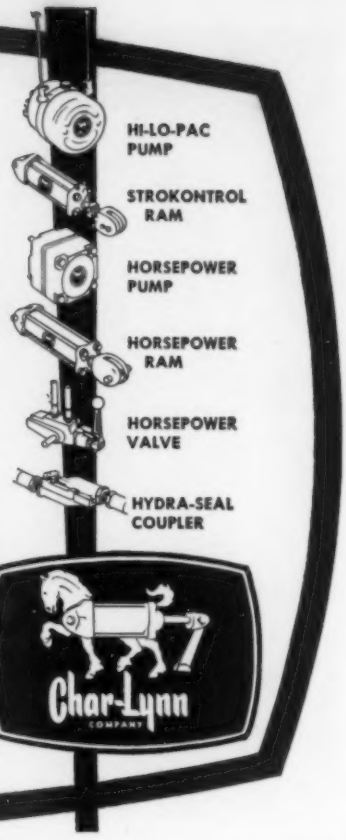
Instant Free Flow

NEW
Char-Lynn
HYDRA-SEAL
HOSE COUPLER

The Char-Lynn Hydra-Seal Hose Coupler has been engineered and designed as a quick-connect self-sealing, break-away coupler for all fluid carrying hoses.

Operation of the Hydra-Seal Coupler is as simple as inserting or removing a plug from an electrical outlet. To couple, hook on and push together; to uncouple, pull apart; no tools are needed. As the barrels are hooked over the slide lugs and the coupler pushed together, the barrels displace the slides and the barrel ports are brought into register or alignment . . . thus allowing the free flow of fluid through the coupler. Pulling the coupler apart brings the slides into position over the ports—oil is sealed in, dirt sealed out.

Let Char-Lynn solve your coupler problems.



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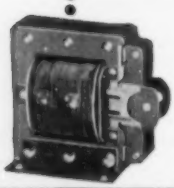

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Dormeyer Coils are precision-wound, quality controlled and can be produced in any quantity to your specifications. Available for every electrical purpose, including fine wire coils up to No. 30 wire.

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Cold Casting Compounds from *Thiokol*® Liquid Polymer

A liquid that converts to a rubber at room temperature without shrinkage.

Thiokol **Liquid Polymer is a solventless liquid that is poured and cured cold and does not undergo dimensional change during handling. It cures to a resilient rubber with the following properties:**

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- ✔ **EXCELLENT LOW TEMPERATURE PROPERTIES**
- ✔ **INERTNESS TO OZONE, SUNLIGHT AND AGING**

The cold casting compound illustrated is made by the Perma-Flex® Mold Company, Columbus 9, Ohio, and is based on a "Thiokol" Liquid Polymer. Thiokol Chemical Corporation supplies "Thiokol" Liquid Polymers only as raw materials for further compounding.

With cold casting compounds based on "Thiokol" Liquid Polymers, intricate cavities are filled with a flexible rubber that conforms precisely to all details of the shape in which it is cast. In the illustrated application, one of these cold casting compounds is being used to produce a flexible core box pattern. Heavy production of precise investment plaster molds for aluminum can be obtained with this type of pattern.

The key properties of "Thiokol" Liquid Polymers have led to their use in other fields besides flexible molds and patterns. Cold casting compounds based on these liquid polymers are now used for the manufacture of printing rollers; large, detailed relief maps; casting seals and gaskets in place on various types of machinery; and for potting electrical and electronic components.

The special attributes of "Thiokol" Liquid Polymers are adaptable to many other applications — wherever an elastomer must meet processing requirements of cold pourability, room temperature cure and no shrinkage — and, wherever outstanding performance is required.

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Send today for this new Handbook. Contains 40 well-illustrated pages of useful design information, engineering data and application studies on our Nickel Alloys.

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"Quality Products since 1919"

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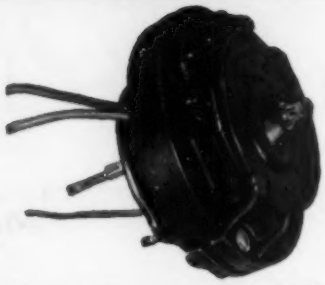

New Capacitor Motor AM-100

Originally developed for TV antenna rotator service. Reversible. Excellent also for laboratory or experimental use: or for advertising displays, etc.

1/100 hp. 2-pole. Operates at free speed of 3300 rpm or load speed of 3100 rpm.

40 watts, 24 volts, 60 cycles, AC.

Skeleton frame, but can be supplied in ventilated case, same size and appearance as Heinze Type Z motor.

Mountings available.

The Heinze catalog shows this and other Heinze sub-fractional horsepower motors and blowers.

Heinze Electric Co
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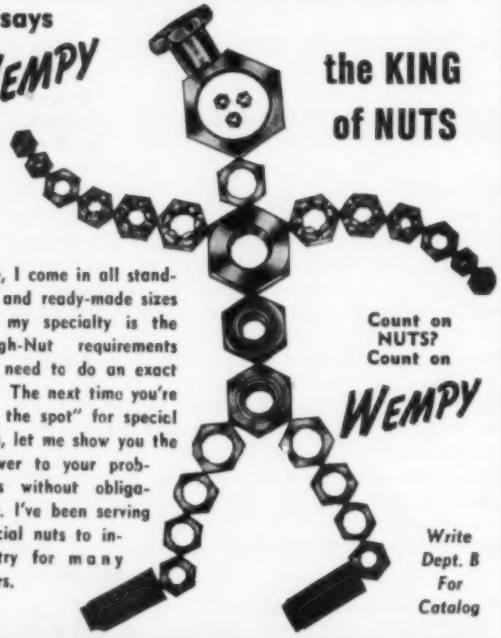
"The TOUGHER the BETTER"
says
WEMPY
the KING
of NUTS



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Count on NUTS? Count on WEMPY

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WESTFIELD METAL PRODUCTS CO., INC.
WESTFIELD, MASS

weight lifters aren't always available

KEEP YOUR PRODUCT

Lightweight!

Power Products new industrial engine offers

60% less engine weight

42% less engine size

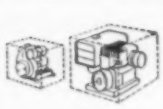
NOW you can give your power equipment the Lightweight being demanded by all of industry. Power Products engines are not just a little lighter—they're 60% lighter than any currently available industrial engine of comparable horsepower . . . and that means greater portability for equipment. Wheels, carriages, etc., formerly necessary for portability, can be eliminated in many cases, allowing further streamlining and extra weight and cost savings.

Power Products engines are more compact in design — easy starting — offer sustained performance at high speeds and are easier to service than any other industrial engines. Yet they actually cost less!

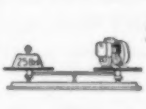
If you want better acceptance — better performance for any industrial product that requires from 2 to 4 horsepower . . . switch to Power Products Lightweight!

LOOK AT THESE FEATURES

Lightweight — A standard 3½ H. P. industrial engine weighs as much as two and one half Power Products industrial engines of 3½ H. P.



Compact — A unique design makes this engine amazingly compact. A comparison of overall dimensions shows a saving of 72% in size over the standard engine.



LOOK AT THE RESULTS — "Pump and motor weigh only 25 lbs.," reports a leading pump manufacturer. This is typical of the kind of amazing lightweight products these engines make possible.

"Only 41 lbs., and usable anywhere, at any angle." Grain auger manufacturers are among the many who have found it possible to revolutionize their products with these engines.

POWER PRODUCTS CORPORATION

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I know what important advantages weight saving can give my products. Please send me full information on these new engines.

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...So far!

PERHAPS YOUR TIMER WILL BE THE 661st

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RE-CYCLING TIMERS • RUNNING TIME METERS

And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries–and of good deliveries even on special orders. Automation? We're in it up to our ears...just put your problem up to one of our timer specialists. Your inquiries will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

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TO SOLVE DESIGN AND PRODUCTION PROBLEMS

REMEMBER THE MANY WAYS AND EASE OF FABRICATION

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- Calendering
- Blow Molding
- Lamination
- Casting
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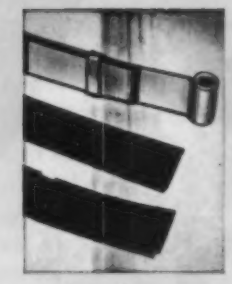

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Pipe

Pipe thread protectors

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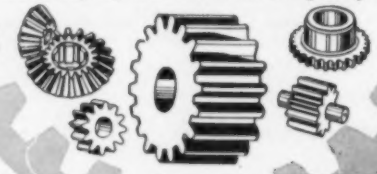

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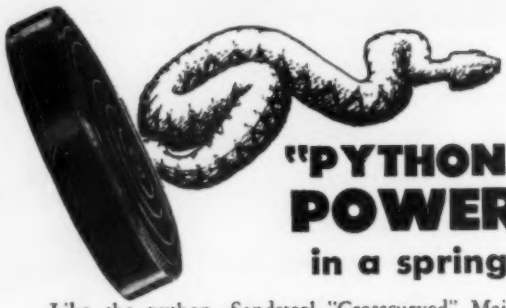

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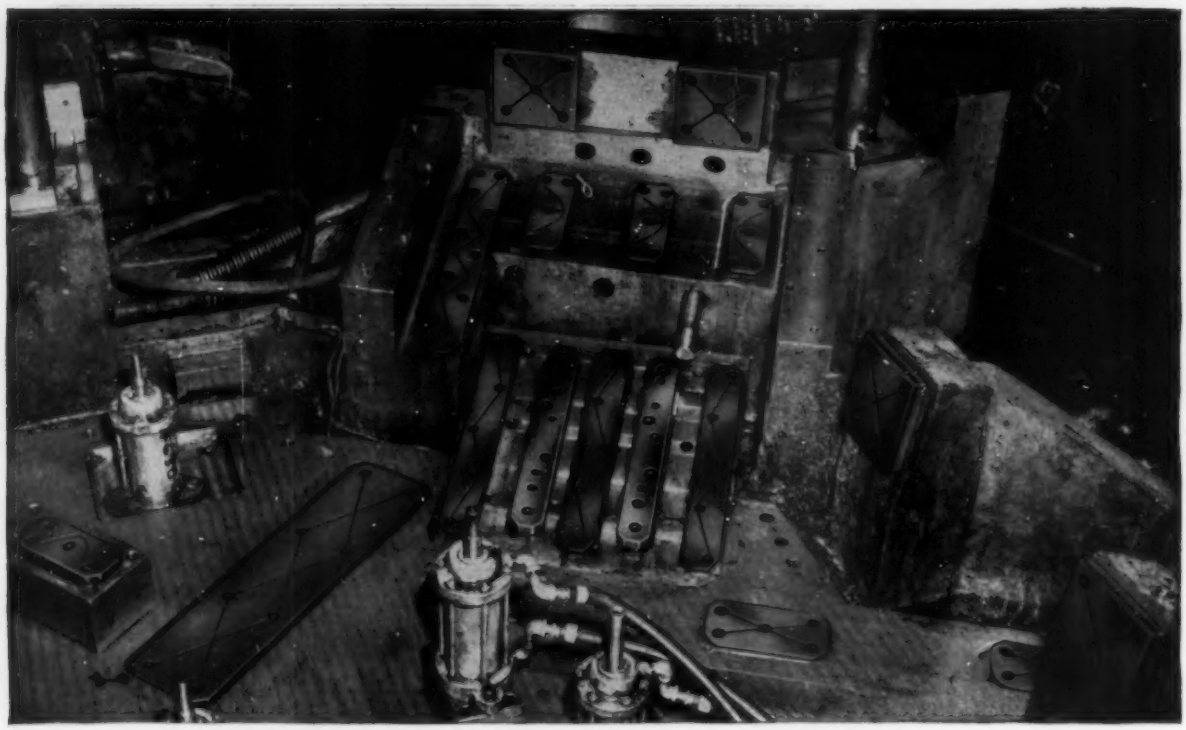

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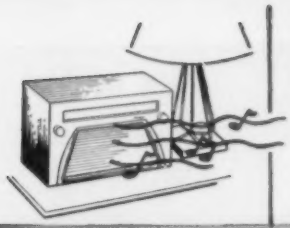

They needed a plastic to make strong, heat resistant radio parts

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• Most people treat radios with care, but accidents do happen. Take small radios, the kind you use in the breakfast nook or at the bedside. They're often jarred or bumped, so they have to take shock and impact.

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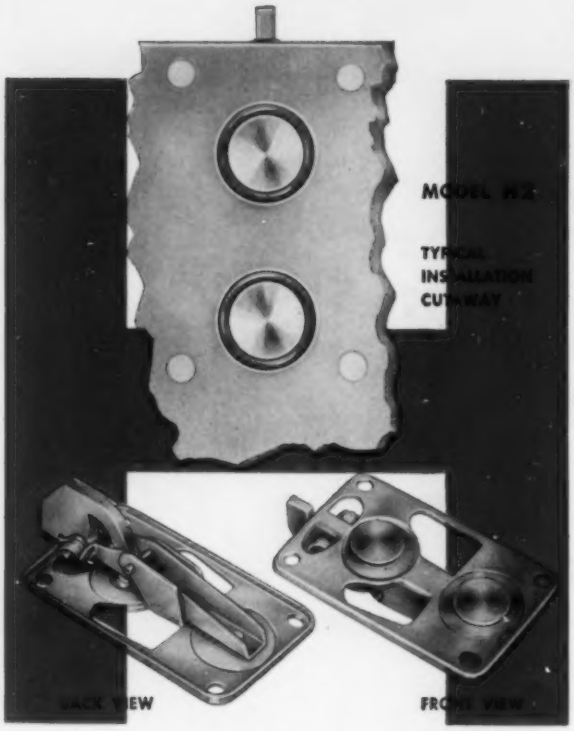

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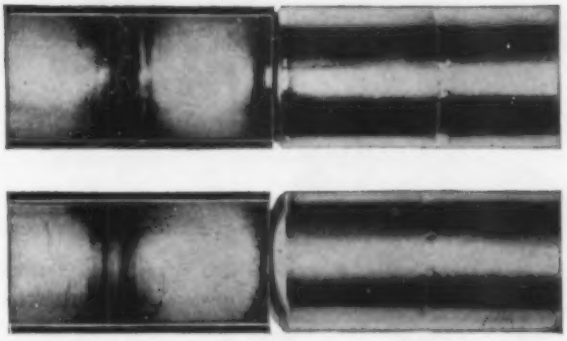

Top—interior and exterior of completed welds without argon backing. Bottom—with argon backing, note the smooth, porosity-free, high quality welds.

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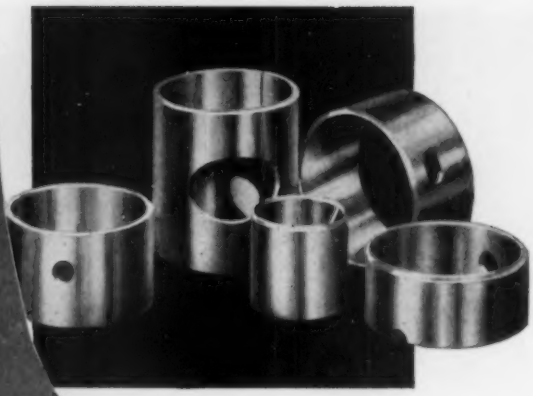

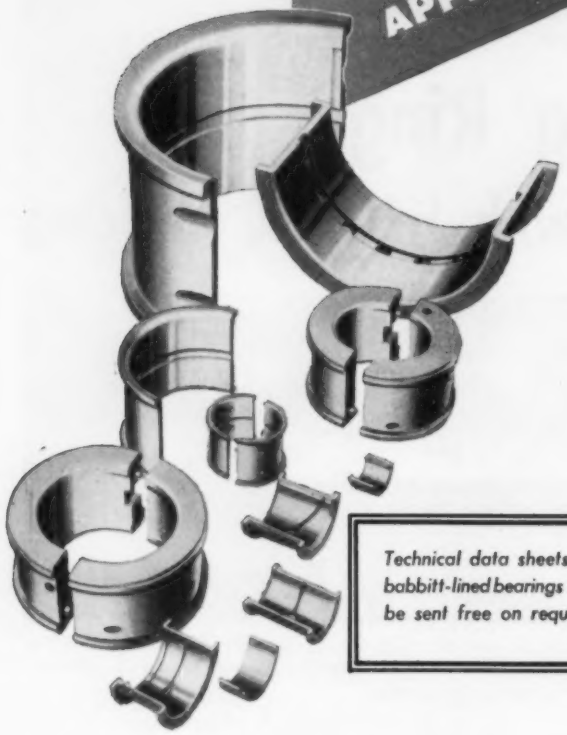

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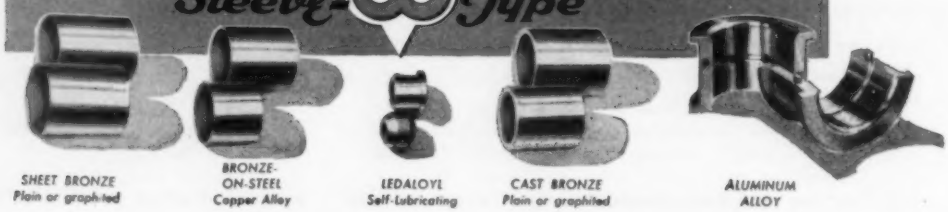

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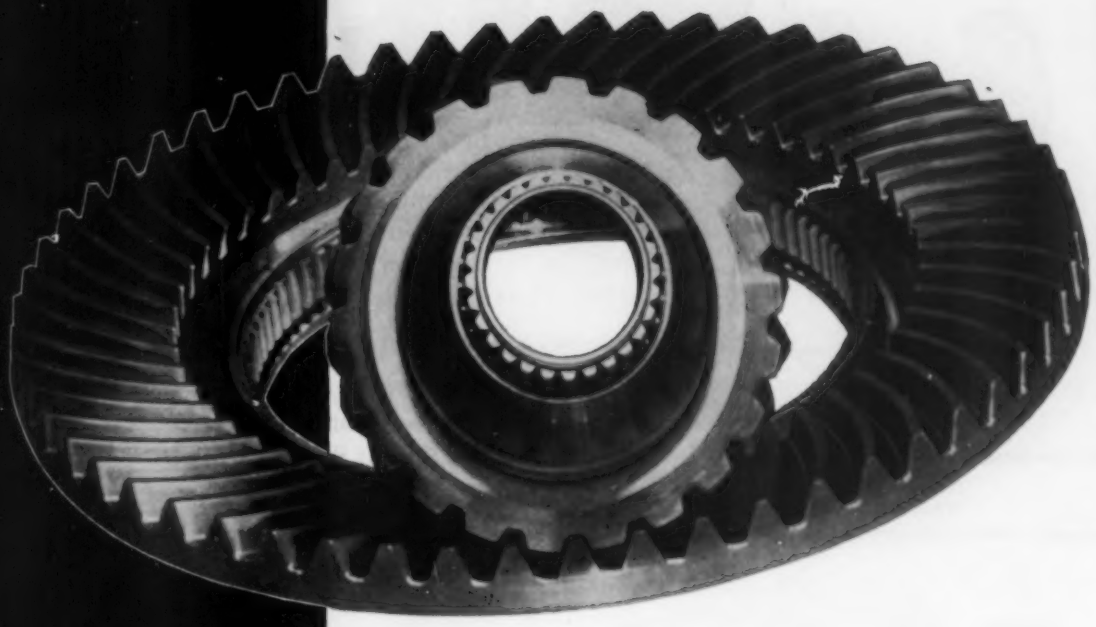

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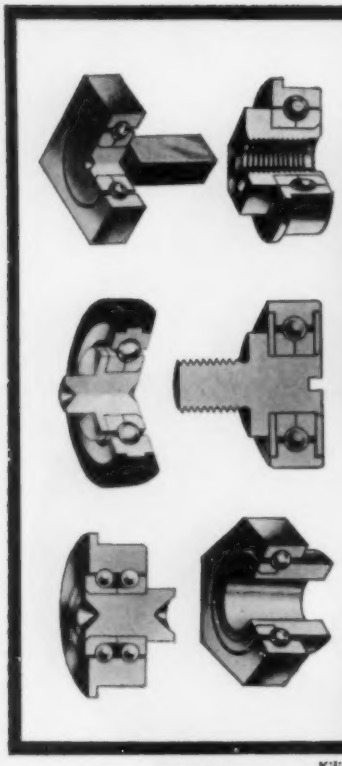

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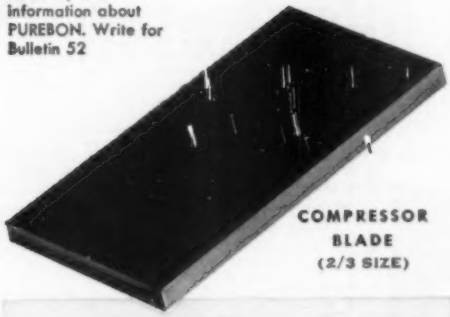

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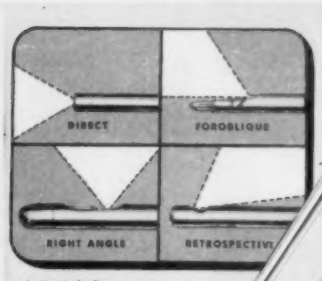

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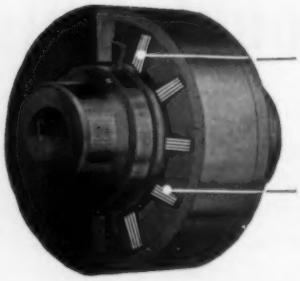

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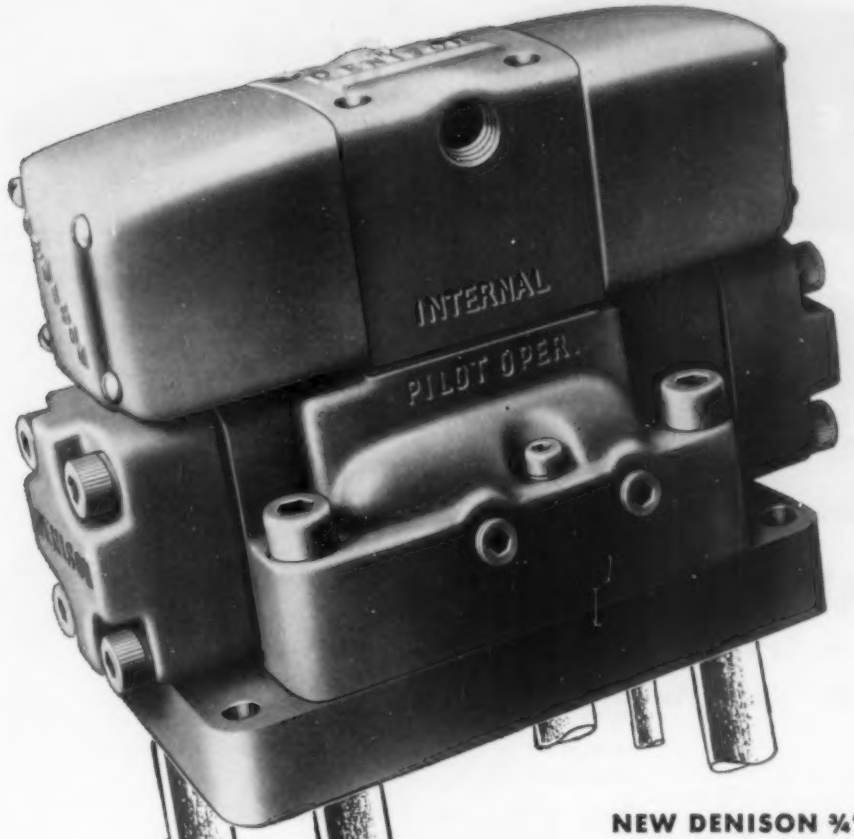

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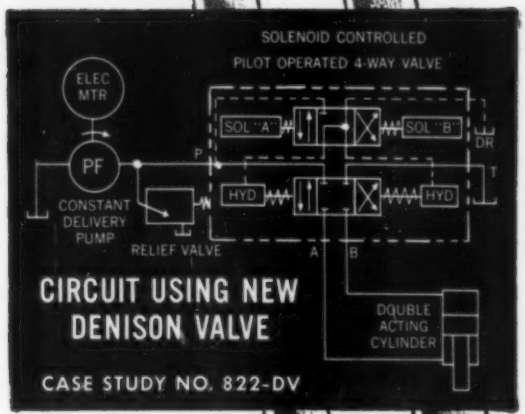

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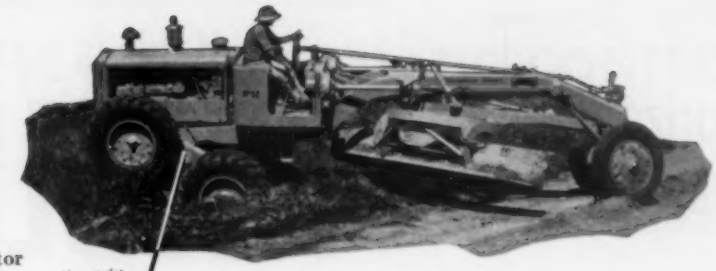

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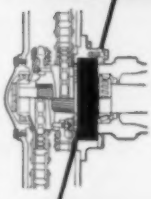

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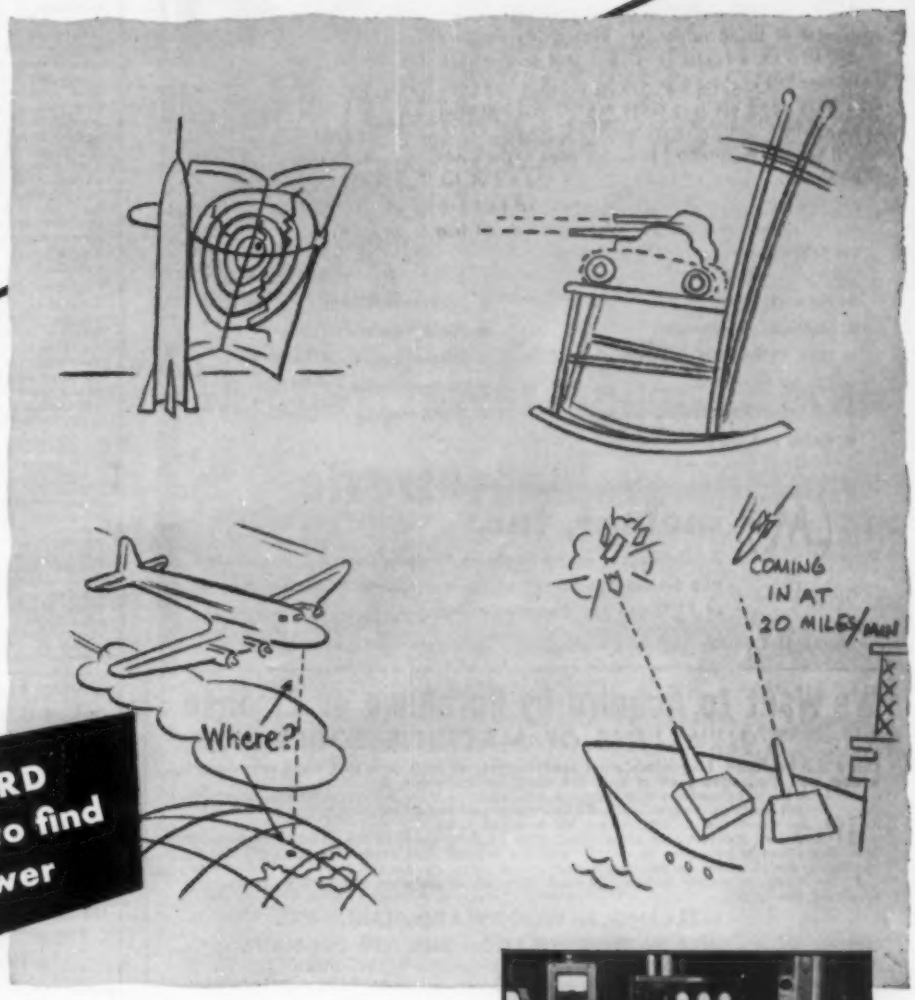

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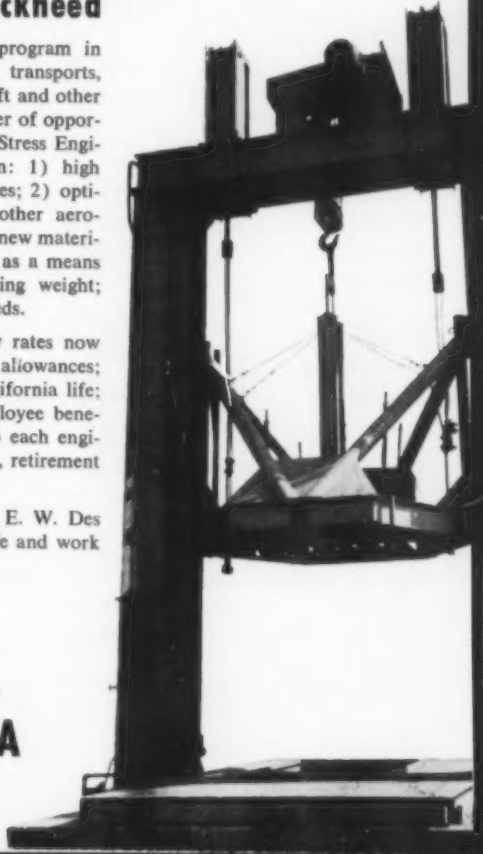

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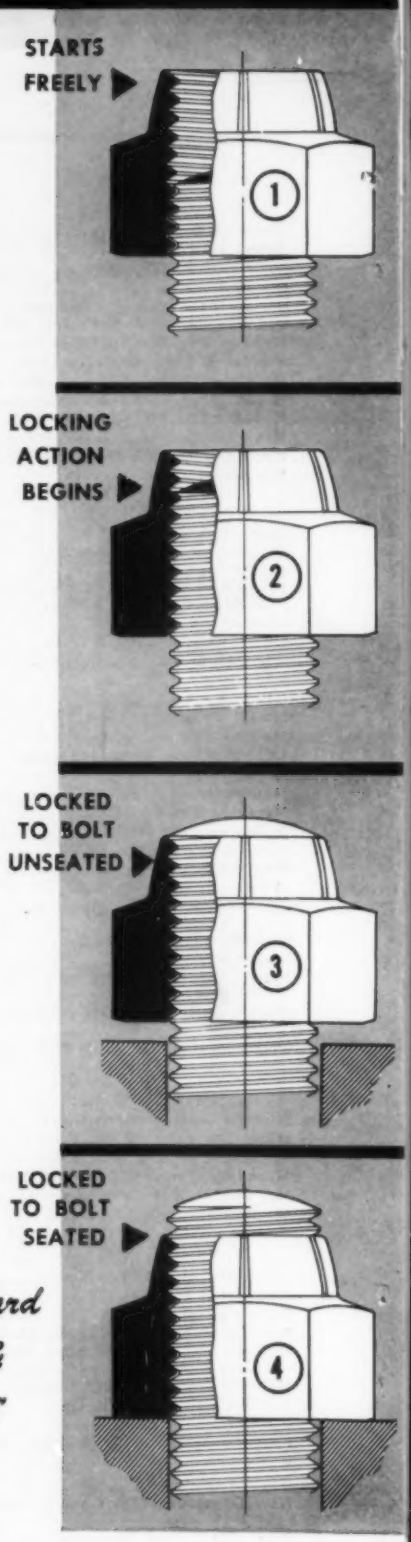

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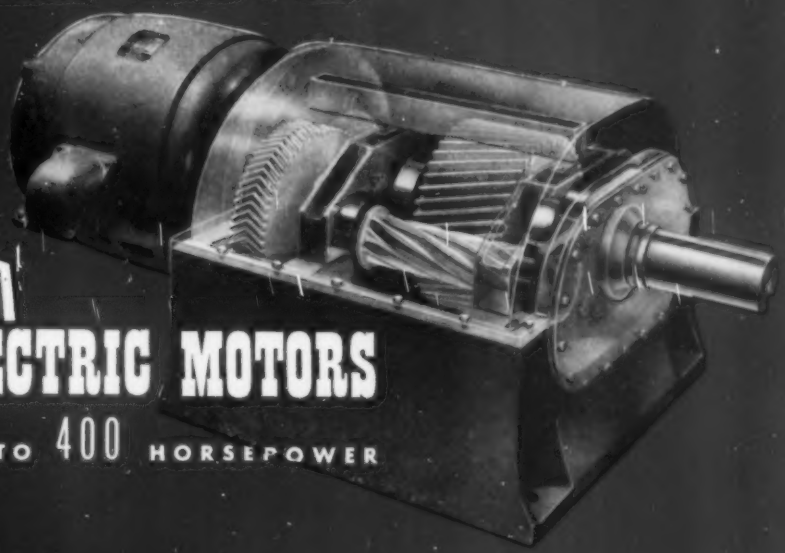

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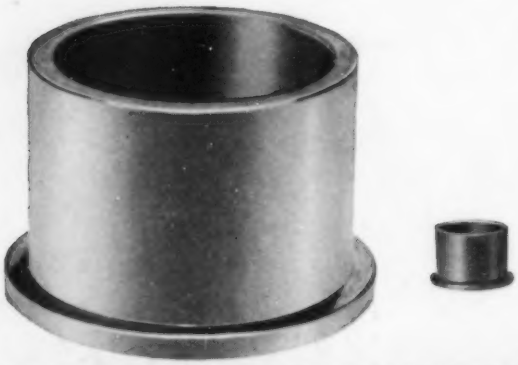

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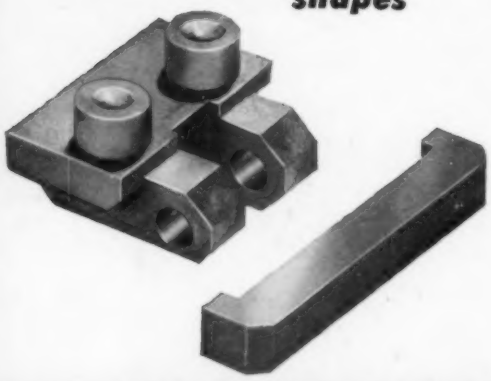

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